Public Health Home Visiting in Montana:

Effects on Low Birth Weight and Premature Births

and Medicaid Costs

By

Jo Ann Walsh Dotson

A Dissertation

Presented to
Oregon Health & Science University
School of Nursing
in partial fulfillment
of the requirement for the degree of
Doctor of Philosophy

May 26, 2009

APPROVED:

_____

Gail M. Houck, Ph.D., R.N., P.M.H.N.P, Professor, Dissertation Chair

_____

Katherine J. Bradley, Ph.D., R.N., Committee Member

_____

Deborah C Messecar, Ph.D., R.N., M.P.H., C.N.S., Professor, Committee Member

_____

Wade Hill Ph.D., A.P.R.N., BC, Assistant Professor MSU, Committee Member

_____

Michael R. Bleich, RN, PhD, FAAN, Dean, School of Nursing

Acknowledgement of Financial Support:

Charles Hoyt Memorial Fund Scholarship Award

March of Dimes Graduate Nursing Scholarship

Acknowledgements

To my dear mother, Edythe Irene Walsh, who inspired me to be a nurse, and continues to inspire me to be a good person..

To my husband, Randy, who never questioned my goal, and encouraged me to pursue my dream.

To my children Valerie and Rebecca for always believing I would succeed.

To my colleagues and coworkers, for their willing ears and steady shoulders.

and

With special thanks to Eric Higginbotham for providing the linked data set, and Dianna Frick, for her SPSS guidance.

ABSTRACT

TITLE: Public Health Home Visiting in Montana: Effects on Low Birth Weight and Premature Births and Medicaid Costs

AUTHOR: Jo Ann Walsh Dotson

APPROVED: _____
Gail M. Houck, Ph.D., R.N., P.M.H.N.P

The purpose of this study was to examine public health home visiting services in Montana; specifically, the study examined the predictive capacity of demographic factors to identify premature and low birth weight births, and to assess the impact of home visiting on birth outcomes and Medicaid costs. The study confirmed findings from other research that prediction of prematurity and low birth weight is not a simple task, and that home visiting is a complex and variable method of service delivery. The research supported previous reports that demographic factors alone are not effective predictors of poor pregnancy outcomes; therefore, home visiting programs should work with medical providers in the community to assure that clients with medical and behavioral risks are referred. The present study did not find significant differences in the incidence of premature or low birth weight birth based on receipt of home visiting services; however, the low birth weight rate was lower in home visited clients, and with concentrated effort on factors strongly associated with low birth weight, notably tobacco use, the potential for significant change in outcome exists. Home visiting services did not appear to affect Medicaid costs for infants born to women who received the services in the prenatal period, however, further investigation using additional data sources and long range Medicaid costs is warranted.

Home visiting is “ingrained” in the maternal child health services nationwide, and as such, must use existing tools and realistic methods to evaluate effectiveness, with a goal of improving what is undoubtedly, and will continue to be, an imperfect but valuable service. Public health nurses are the primary providers of home visiting services in Montana, and arguably, in the U.S. If we are to improve the services, we must use available data to document effects.

Home visiting programs may best serve the maternal child health population by clearly establishing goals and objectives, and by using available data, including birth certificate and Medicaid data, to assess if programs are achieving their stated goals. Community based programs can, with the help of state partners, monitor their effectiveness and target populations or needs based on their needs.

Table of Contents

List of Tables

List of Figures

CHAPTER I

Introduction and Purpose of the Study

Birth outcomes are important to the health of a society. Pregnancy is a period of new beginnings, offering families the opportunity to extend and create new members of the society. New members may be contributing members and thrive, or may have health care or social problems that burden society, requiring supplementary financial and human resources to survive.

There were 4,112,052 births in the United States in 2004. Preterm births, (< 37 weeks of completed gestation) accounted for 9.7% of births in 1994 and 12.5 % in 2004. The incidence of low birth weight birth (≤ 2,500 grams) has also increased, from 6.2% of births in 1994, to 7.6% of births in 2004 (J. Martin et al., 2006; NCHS, 2007a). Low birth weight births and premature births are major contributors to infant mortality (R. Goldenberg & Rouse, 1998; Guillory, Samuels, Probst, & Sharp, 2003; Kochanek & Martin, 2005). The U.S. infant mortality rate was 6.8 deaths per 1,000 live births in 2004, down from 8.0 in 1994, but the rate of decrease has slowed over the last decade, and actually increased to 7.0 in 2002 from 6.8 in 2001. The U.S. infant mortality rate is high among industrialized nations, two to three times higher than the rates in Hong Kong, Singapore and Japan (Hamilton et al., 2007). Rural and frontier communities in the United States are also experiencing increases in the incidence of these indicators of poor birth outcomes. Montana's low birth weight rate was 8.1% in 2004, increased from 7.3 % in 1994, and the prematurity rate was 11.6% in 2004, an increase from 9.7 % in 1994 (DPHHS, 1995b, , 2005).

Influences on Birth Outcomes

Birth outcomes are influenced by demographic, medical, and behavioral risk factors. Medical risk factors, including those occurring prior to and during pregnancy, can negatively affect outcomes. Psychological and behavioral factors such as stress, substance use, and domestic violence are frequently inter-related and can negatively affect birth outcomes. Environmental risks include exposures to toxins in the work place, home and community, and can also negatively affect pregnancy and birth outcomes. Various methods of mitigating these risk factors have been explored and employed by health care providers and social service programs in the U.S. over the last century. These methods include medical care in the form of prenatal visits, programs to improve nutrition and nutrition education (Women, Infant and Children's Supplemental Nutrition Program or WIC), financial support programs such as the Temporary Assistance for Needy Families (TANF), and home visiting programs that support families with education, referrals and social support during and following the prenatal period. Despite these efforts, the rates of premature and low birth weight birth rates are escalating in the U.S.

Home Visiting

Home visiting is a method of service delivery that can both identify and influence factors that may negatively impact birth outcomes. Olds and Kitzman (1990) asserted that home visiting holds "considerable promise as a means of augmenting office-based and clinic-based efforts" to serve families and address their needs (Olds & Kitzman, 1990, p. 114). In modern society, prenatal care and social services are perceived by both health providers and policy makers as having the potential to improve birth outcomes and, more

broadly, “life outcomes” that improve the capacity of the pregnant woman and her family to nurture and support the infant and child (Hanks, Kitzman, & Milligan, 1995; Page, 2004; Renker, 1999; R. O. Roberts et al., 1998). Research documents some positive influences of home visiting on the incidence of premature and low birth weight births, and on other maternal/child health outcomes including motor and/or cognitive development of infants, health services utilization, incidence of child abuse, quality of social support, substance use, and maternal and child physical and mental health (Behrman, 1999; Black et al., 1994; M Byrd, 1997; D. Olds, Henderson, Kitzman, & Cole, 1995; D. Olds, Hill, Robinson, Song, & Little, 2000).

An integrative review of twenty high quality experimental and quasi experimental studies revealed that home visiting programs targeting birth outcomes, maternal infant interactions, and parenting were more successful than programs targeting child development and health service utilization (Kearney, York, & Deatrick, 2000). Higher birth weights and lower incidence of premature birth has been reported by some researchers for some populations (Fetrick, Christensen, & Mitchell, 2003; D. Olds, Henderson, Tatelbaum, & Chamberlin, 1986), however other researchers have reported limited improvements in maternal or infant outcomes, especially improvements at clinically significant levels (Norr et al., 2003; Persily, 2003; Schuler, Nair, & Kettinger, 2003). These disparate findings are evidence of the need for further study. The U.S. spends more on health services per capita than all other industrialized nations, yet our infant mortality rate was worse than twenty seven nations in 1998 (G. Anderson, Frogner, Johns, & Reinhardt, 2006; OMH, 2007). If we are to stem the tide, we must focus on preventing poor outcomes rather than treating them. We must have in place efficient and

effective evaluation methods that can be used to assist policy makers to target resources and efforts to those populations or problems that can benefit from the services. We must also be prepared to stop delivering services that do not work, and redirect resources to those that demonstrate improved outcomes.

Home visiting (HV) for women and children has been and continues to be a service often provided by public health nurses. Despite the long history of HV, documentation of evidence regarding the effectiveness of the service to improve birth outcomes continues to be elusive (M Byrd, 1997). Even proponents of home visiting services, including researchers Olds and Kitzman, recognize limitations: "many home visitation programs simply do not work" (Olds & Kitzman, 1990, p. 108). However, despite the lack of clear documentation, home visiting continues to be supported by federal, state and local policy makers and funders (Olds & Kitzman, 1990; D. Olds, Hill, Robinson, Song, & Little, 2000). According to a report from the David and Lucille Packard Foundation, the number of pregnant women and children served by HV programs in the US has more than doubled to 550,000 between 1993 and 1999 (Behrman, 1999). The reasons for the infusion of dollars into these programs may include the recognition that home visiting is a unique service strategy; home visiting can reach clients who can not or will not receive or accept services in office or institutional settings, thereby enhancing the receipt of medical and social services that may improve birth outcomes and infant and child health. (Kearney, York, & Deatrick, 2000).

Purpose of the study

The purpose of this study was to examine birth outcomes, specifically premature and low birth weight births in high risk women and Medicaid costs for infants born to

high risk women in Montana, and to determine if home visiting effected those outcomes and costs. This quasi experimental, retrospective case control design examined the outcomes of births to women in Montana in 2006, using population based data (birth certificates) linked to Medicaid and home visiting data. The comparison of women with similar demographics offered a unique and useful perspective, as research on HV has typically compared outcomes for a high risk group to those for a lower risk population-based outcome.

Research Question

The research study sought to answer the question; does home visiting impact birth outcomes, specifically the incidence of premature and low birth weight births and subsequent Medicaid costs for infants born to women receiving home visiting services? Specific aims of the research were to:

- determine the capacity of demographic factors to predict premature and low birth weight birth in Montana;
- examine the effect of home visiting on select birth outcomes, after controlling for adequacy of prenatal care; and
- compare the Medicaid costs for infants whose mothers did and did not receive home visiting services, after controlling for adequacy of prenatal care.

Significance of the Research to Nursing

Low birth weight and prematurity are public health concerns; together, disorders related to preterm birth and low birth weight were the second leading cause of infant mortality in the U.S. in 2005 (Kung, Hoyert, Xu, & Murphy, 2007). Home visiting for pregnant women in Montana, as in many other states, is a service which is provided and

guided in great part by public health nurses. Because of their role in service delivery, it is appropriate that the nursing profession actively participate in efforts to document if the service methodology is useful, efficient and cost effective.

Approximately 1,000 pregnant women received public health home visiting services in Montana in 2006. Resources to provide the service are from public health budgets. Home visiting is an expensive public health service, with costs estimated at $5,000 - $9,000 per family served (ASTHO, 2006). In this era of cost cutting, home visiting is one of many service delivery methods that are being carefully examined. It is important that HV be carefully evaluated and the decision to continue, expand or modify the model be based on sound research which can help improve the potential for positive outcomes for the clients (Kearney, York, & Deatrick, 2000). Despite the challenges of delivering the service, especially in rural settings, it continues to be popular with policy makers and the public in Montana, who ascribe to the "stitch in time saves nine" notion. As public health leaders, designers, and deliverers of services to the maternal child health (MCH) population, it is the responsibility of the nursing profession to help document if and how HV can improve health outcomes in rural settings. The findings from this study will assess the impact of home visiting in 2006, and help to test a mechanism for ongoing evaluation of home visiting in Montana.

CHAPTER II

Review of Literature

Public Health and Pregnancy Outcomes

Public health systems strive to not only prevent disease, but to improve the quality of life. The primary goals of Healthy People 2010 are to: 1) help individuals of all ages increase life expectancy and improve their quality of life, and 2) eliminate health disparities among different segments of the population (DHHS, 2007). Maternal, Infant, and Child Health objectives of Healthy People 2010 include decreasing the incidence of fetal and infant mortality (Objective 16-1), decreasing the incidence of maternal illness and complications due to pregnancy (Objective 16-5), and decreasing the incidence of low birth weight (Objective 16-10) and premature births (Objective 16-11).

Healthy People goals and objectives may best be met by providing the public with services that promote healthy lifestyles and that increase participation in health care and healthy choices. In 1989, the National Commission to Prevent Infant Mortality published a report, *"Home Visiting: Opening Doors for America's Pregnant Women and Children,"* that identified public health home visitation as a mechanism with the potential to address the problem of infant mortality and other poor pregnancy outcomes (NCPIM, 1989), by offering case management, education, and social support services to pregnant women and young children, with the goals of improving the health and well being of women and children in the U.S. (Behrman, 1993).

Public health home visiting (PHHV) programs differ in their goals, target populations, program content and curricula, service providers, and frequency and intensity of interventions (Behrman, 1993). PHHV programs have proliferated over the last 20

years, with the number of women served by PHHV programs doubling between 1993 and 1999, reaching an estimated 550,000 individuals (Behrman, 1999). Montana's public health home visiting program began in the mid 1980's, and presently serves approximately 15% of the state's pregnant women and their infants each year. This study examined the factors influencing birth outcomes, assessed the impact of home visiting services on low birth weight and prematurity rates in high risk populations, and evaluated the associated Medicaid costs in Montana.

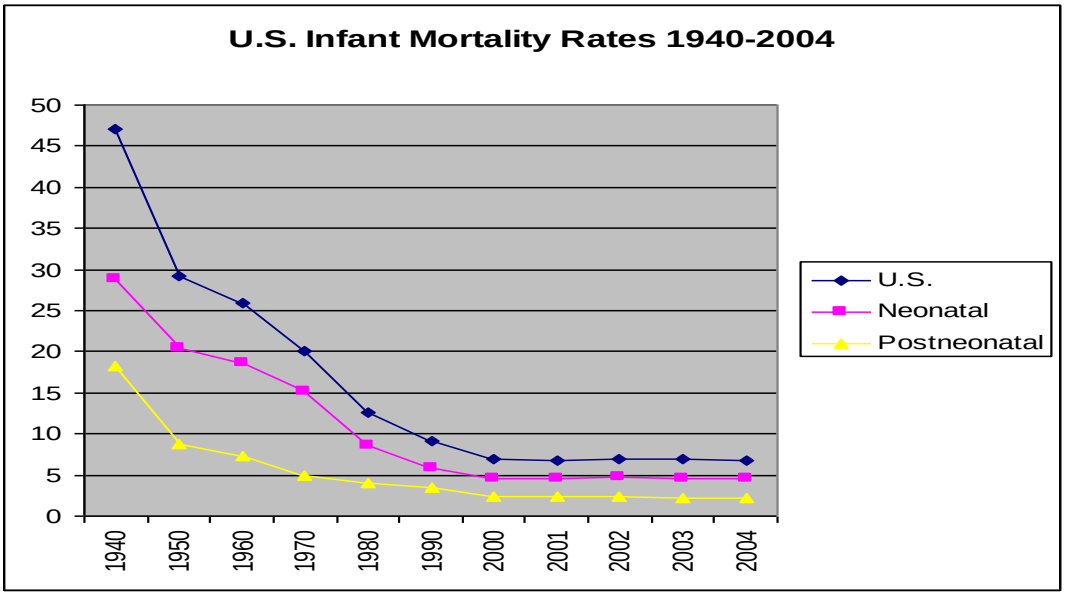
Birth Outcome Measures

Commonly accepted measures of birth outcome status include infant mortality, birth weight, and gestational age. For the current study, the primary measures of birth outcome were low birth weight (<2500 grams) and premature birth (<37 completed weeks of gestation). These measures are available on the birth and death certificates and are strongly associated with infant mortality (R. Goldenberg & Culhane, 2007; Hamilton et al., 2007).

Infant Mortality

Infant deaths (mortality) occurring prior to a child's first birthday is a typical measure of not only pregnancy outcome but of societal health. Disorders related to short gestational age and low birth weight were the second leading cause of infant deaths in the U.S. in 2004, accounting for 36.5 % or 10,180 of the 27,860 infant deaths. Only congenital malformations and chromosomal abnormalities resulted in more infant deaths (MacDorman, Munson, & Kirmeyer, 2007). In the U.S., infant mortality decreased from a rate of 47 deaths per 1,000 live births in 1940 to a rate of 6.8 deaths per 1,000 live births in 2004 (see Figure 1).

Figure 1: United States and Montana Infant Mortality Rates 1940-2004



Despite the decrease in the incidence of infant mortality, the U.S. continues to have a high infant mortality rate compared to that of other industrialized nations (NCHS, 2002). In 2003, the most recent year that international comparisons are available, the U.S. was ranked 26th among industrialized nations for infant mortality. Hong Kong and Singapore had the lowest infant mortality rates; at 2.3 and 2.7 per 1,000 live births, respectively (Hamilton et al., 2007).

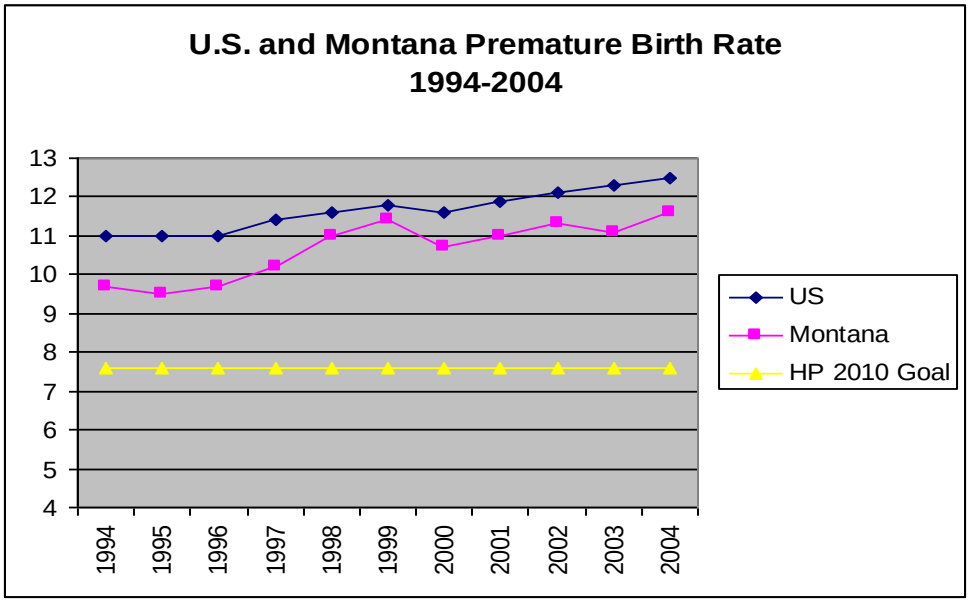
Prematurity

Premature birth is a leading cause of infant morbidity and mortality. Almost one-half of congenital neurological defects and two-thirds of infant deaths are attributable to prematurity (R. Goldenberg & Rouse, 1998; J. Martin et al., 2006). Prematurity is a cause for concern; babies born early, even those born only a few weeks early at 35 or 36 weeks gestation (labeled “near term”), have been found to be more likely to have clinical complications than full term babies born between 37 and 40 weeks gestation (M. Wang, Dorer, Fleming, & Catlin, 2004).

Premature births are defined as those occurring before 37 weeks of gestation; births occurring between 37 and 41 weeks of gestation are considered term and those after 42 weeks of gestation are considered post term (CDC, 1993). Gestational age is calculated as the interval before the first day of the mother's last normal menstrual cycle and the date of birth. A clinical estimate of gestation, based on an assessment of physical and neurological findings, is usually completed within the first 12 hours of life (Ballard et al., 1991). The calculated gestational age is most frequently reported on the birth certificate; the clinical estimate is used only when the computed length of gestation appears to be inconsistent with birth weight or if the last menstrual period was not reported. In 2004, only 5.9% of the reported gestational ages were based on a clinical estimate (Mathews & MacDorman, 2007).

The rate of premature birth has been increasing over the past decade, from 11.0 to 12.5 per 1,000 live births between 1994 and 2004. For the same years in Montana, the premature birth rate has increased from 9.7 to 11.6 (MOD, 2005). (See Figure 2)

Figure 2: United States and Montana Premature Birth Rates 1994-2004



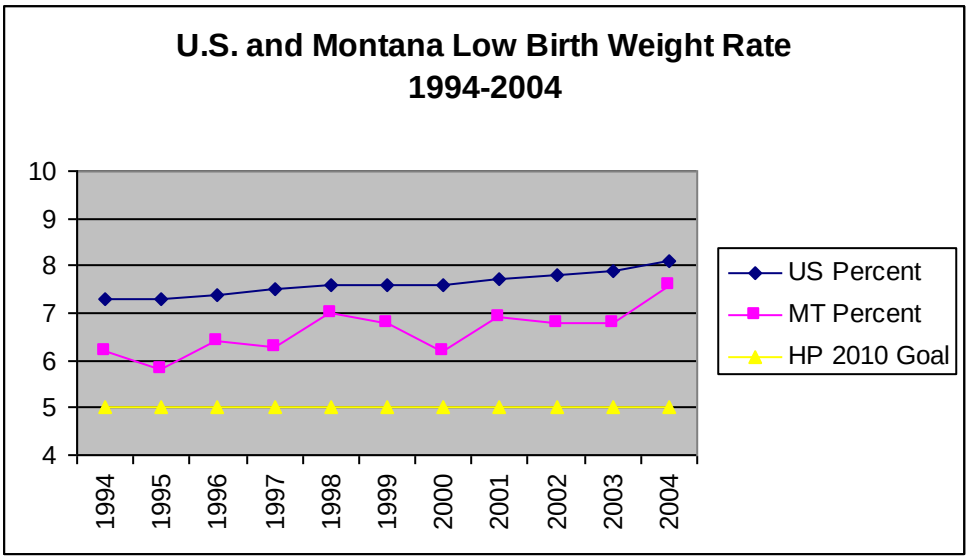
Increased incidence in preterm births is not unique to the United States. With few exceptions, most industrialized countries have experienced an increase in premature births (Joseph et al., 1998). Nonetheless, approximately 470,000 babies are born prematurely each year in the U.S.; this means there are 1,300 premature babies born per day, and of those 12 die (Lockwood, 2002).

Researchers have variously categorized the causes of premature birth. According to Goldenberg and Rouse, spontaneous premature labor accounts for 50% of premature births, spontaneous rupture of membranes for 30%, and assisted delivery for the benefit of the infant and/or mother accounts for the remaining 20% (R. Goldenberg & Rouse, 1998). Moore reported a slight variation in these numbers, attributing 40% of premature births to idiopathic causes and another 40% to premature rupture of the membranes, and the remaining 20% to medically necessary intervention (M. Moore, 2003).

Low Birth Weight

Low birth weight is defined as an infant weighing less than 2,500 grams or 5 pounds, 8 ounces at birth (NCHS, 2007a). Moore categorized low birth weight births into four groups: (1) term low birth weight; (2) preterm low birth weight attributable to medical interventions relating to the health of the mother, the fetus, or both; (3) preterm low birth weight attributable to spontaneous or idiopathic causes; and (4) preterm low birth weight due to premature rupture of the membranes (M. Moore, 2003). (See Figure 3)

Figure 3 United States and Montana Low Birth Weight Rates 1994-2004



Martin and associates calculated that two-thirds (67%) of low birth weight babies born in the United States in 2003 and 2004 were also premature (J. Martin et al., 2006; J. Martin et al., 2005). Factors that contribute to the low birth weight of full term babies include many of the same risk factors for prematurity.

Costs of Premature and Low Birth Weight Births

The expenses associated with prematurity and low birth weight are of great concern to policy makers and care providers. In 2003, the cost of hospital care for newborns in the United States was over $10 billion, with more than half of that amount spent on the 12.3% of infants born prematurely (Cuevas, Silver, Brooten, Youngblut, & Bobo, 2005). Infants that are *both* premature and low birth weight have longer hospital stays and incur higher costs than normal birth weight babies; the average cost of $9,190 per hospital stay is almost seven times higher than cost for a normal birth weight baby at $1,355 per hospital stay (Guillory, Samuels, Probst, & Sharp, 2003). These initial hospitalization costs present only the tip of the ice berg. Stevenson and associates reported that infants weighing between 1501 and 2000 grams at birth had hospital costs

during the first year of life that were double that of infants born over 2500 grams (Stevenson, Pharoah, Stevenson, McCabe, & Cooke, 1996). Costs for medical care of extremely low birth weight infants (those whose weight is less than 1,000g at birth) were 25 times greater in the first two years of life than for those of a normal birth weight infant (Tommiska, Tuominen, & Fellman, 2003).

Disparity in the cost of health care costs between normal weight and full term infants, and premature and low birth weight infants does not end in infancy. The potential lifetime costs of caring for a child with health complications attributable to prematurity or low birth weight birth, such as cerebral palsy, developmental delay, respiratory problems, and sensory challenges, must be considered (Cuevas, Silver, Brooten, Youngblut, & Bobo, 2005; Lockwood, 2002; Rushing & Ment, 2004). The March of Dimes estimated the societal economic cost (medical, educational, and lost productivity) attributed to preterm birth in the United States was at least $26.2 billion dollars in 2005 (MOD, 2007). Costs attributable to low birth weight birth are also great; very low birth weight infants were estimated to incur health care costs during the first two years of life that were 25 to 68 times more (depending upon the degree of disability) than the cost of a normal birth weight infant (Tommiska, Tuominen, & Fellman, 2003).

Factors Contributing to Low Birth Weight and Premature Birth

The Institute of Medicine's report, *Preventing Low Birth Weight*, categorized factors contributing to low birth weight as demographic factors, medical conditions both preceding and occurring during the pregnancy, behavioral and environmental factors, and "evolving" concepts, such as stress (IOM, 1985). Factors attributing to the incidence of prematurity include many of the same factors (Berkowitz & Papiernik, 1993; Bibby &

Stewart, 2004; Iams, 2003; Tucker & McGuire, 2004; Wen, Smith, Yang, & Walker, 2004).

For the purposes of this study, the primary measures of birth outcome were low birth weight (< 2500 grams) and premature birth (< 37 completed weeks of gestation). These measures are available on the birth and death certificates and are strongly associated with infant mortality (R. Goldenberg & Culhane, 2007; Hamilton et al., 2007). The following section identifies risk factors that have been associated with increased incidence of low birth weight and premature birth.

Demographic Factors

Demographic factors can be powerful predictors of low birth weight and prematurity, and recognition of those factors may assist health programs and practices to identify and target women at risk for poor birth outcomes. Goodwin and associates identified seven demographic variables that accurately identified approximately 72% of the premature births in a population based analysis. These demographic variables were: 1) maternal age, 2) residency status, 3) education, 4) marital status, 5) payer source, 6) race, and 7) religion. The addition of hundreds of other variables improved the predictive accuracy by only a 4% (L. Goodwin et al., 2001). Each of the demographic variables, with the exception of religion, is discussed in the following section. Religion was omitted due to a lack of research reporting on associations between religious affiliation and birth outcomes.

Maternal Age.

Maternal age, on either end of the childbearing age spectrum between 15 and 44 years, is associated with a higher incidence of both low birth weight and preterm births.

Births to women aged less than twenty years accounted for 10% of the total births in the United States and 11% of total births in Montana (NCHS, 2007a). The risk of premature birth is two to four times higher in very young women (aged 13 to 14 years) compared to 25-year-old women, however the increased risk of premature birth persists throughout the teenaged years (Abel, Kruger, & Burd, 2002; Akinbami, Schoendorf, & Kiely, 2000). The incidence of low birth weight birth is also higher among young women; in 2004, the low birth weight rate was 9.9% for women between 15 and 19 years, compared to a rate of 7.3% for women between 25 and 29 years of age (J. Martin et al., 2006).

Low birth weight and prematurity in teens have often been attributed to socioeconomic disadvantage. However, in another large population-based study, the risk of low birth weight and premature birth remained high even after adjusting for commonly identified socioeconomic factors including marital status, education, and adequacy of prenatal care (Fraser, Brockert, & Ward, 1995). Some researchers attribute the incidence of low birth weight and premature births in teens to physiologic immaturity and inadequate nutrition (Borja & Adair, 2003; Kirchengast & Hartmann, 2003).

The increased incidence of low birth weight and premature births in older women is also of concern, considering the fact that births to older women, defined as women 35 years and older, have increased. Birth rates have doubled in women 35 years of age and older, from a rate of 52.3 births per 1000 women in 1970 to 95.6 births per 1000 in 2001. Women aged 35 years and older accounted for over 14% of the births in the United States in 2004, an increase from 8.8% of births in 1990 (NCHS, 2007a). Increased risk of low birth weight and premature birth is associated with chronic illnesses, such as hypertension and diabetes, which are more likely to occur in older women (Cleary-

Goldman et al., 2005; Neumann & Graf, 2003). Older women are also more likely to have multiple births, attributed in part to assisted reproductive technology; multiples are more likely be low birth weight or premature than singleton births.

Newburn-Cook and Onyskiw conducted a systematic review of the literature to examine associations between advanced maternal age and preterm delivery. Risk increased with maternal age, although methodological challenges resulted in variable findings (Newburn-Cook & Onyskiw, 2005). Increased risk was also reported in studies not included in the review, including one by Abel and associates, who reported increased risk of preterm birth in both Caucasian and American Indian women between 36 and 45 years of age compared to women between the ages of 21 to 25 years (Abel, Kruger, & Burd, 2002). Another study reported that risk for women between 35 and 39 years of age did not differ significantly from younger women, but that risk did increase in women 40 years of age and older (Cleary-Goldman et al., 2005).

Researchers have also documented increased incidence of low birth weights of infants born to older women. A large study conducted in Spain revealed that women 35 years of age had increased risk of preterm low birth weight infants when compared to a referent group of women aged 25 to 29 years (Rodriguez, Regidor, & Gutierrez-Fisac, 1995). Notable in that study was that the incidence of low birth weight in term births for older women was lower than the low birth weight rate of the referent group. In a smaller study of Austrian women, the mean birth weight of infants was significantly lower for newborns of women aged 40 years and older compared to women between 20 and 30 years of age (Scholz, Haas, & Petru, 1999). Other studies conducted in the U.S. also

reported increased incidence of low birth weight births in older women (Cleary-Goldman et al., 2005; Montan, 2007).

Residency.

Residency is defined as the place one lives (Guralnik, 1982). The place of residence is reported on birth and death certificates and other legal documents. For research and designation purposes, residency status is often categorized. Rural, urban, frontier, and metropolitan are frequently used residency categories. In health research, rural residency is associated with certain demographics that differ from urban or other populations. Women in rural settings tend to have higher poverty and lower education levels, and fewer employment opportunities (Bushy, 1998; Shitener & McGranahan, 2003; Weber & Jensen, 2004). Women in rural settings also have more limited access to health insurance and providers, which in turn results in low health care utilization, including less than adequate prenatal care (T. Bennett, 2002; Casey, Thiede Call, & Klingner, 2001; Peck & Alexander, 2003).

There is no universally accepted definition or categorization of rural status. The U.S. Census Bureau's Urbanized Area (UA) categorization of census blocks and block groups and the Office of Management and Budget (OMB) designation of counties are the most commonly used (Coburn et al., 2007). Both define rural by exclusion; urban or metropolitan areas are defined and then all areas *not* urban or metropolitan are designated as rural. Categorizations were often developed for particular programs or purposes, using different "building blocks" such as counties, zip codes areas, or census block or tracts. The Rural Health Research Center at the University of Washington developed a system of categorizing communities based on standard Census Bureau Urbanized Area and

Urban Cluster definitions, incorporating work commuting data. The Rural Urban Community Area Codes (RUCAs) designate communities based on the size of the community and commuting status, indicating resource availability, including health care access. RUCAs are more sensitive than county level designations; this increased sensitivity is appropriate in Montana, where counties the size of Rhode Island often include both urban and very rural areas. The Health Research Center has assessed and designated codes to many areas in the Northwest, including Montana, and made those available in the form of zip files to researchers (Hart, 2006). The Health Research Center has also established groupings of those designations; Table 1 presents categorizations recommended by the center for health research purposes (WWAMI, 2006).

Table 1 **Rural-Urban Community Area Codes**

Categorization	Community Grouping Levels	Codes
A	Urban focused	1.0,1.1,2.0,2.1, 2.2,3.0, 4.1,5.1,7.1,8.1, 10.1
	Large rural City/town focused	4.0,5.0,6.0
	Small Rural Town focused	7.0,7.2,7.3,7.4,8.0,8.2,8.3,8.4,9.0,9.1,9.2
	Isolated Small rural town focused	10.0,10.2,10.3,10.4,10.5
B	Urban	1.0,1.1,2.0,2.1,2.2,3.0,4.1,5.1,7.1,8.1,10.1
	Large Rural City/Town	4.0,5.0,6.0
	Small Rural Town	7.0,7.2,7.3,7.4,8.0,8.2,8.3,8.4,9.0,9.1,9.2,10.0, 10.2,10.3,10.4,10.5
C	Urban	1.0,1.1,2.0,2.1,2.2,3.0,4.1,5.1,7.1,8.1,10.1
	Rural	4.0,5.0,6.0,7.0,7.2,7.3,7.4,8.0,8.2,8.3,8.4,9.0,9.1, 9.2,10.0,10.2,10.3,10.4,10.5

Hillemeir and associates used the four-level Categorization A RUCA coding in their research on individual and community predictors for low birth weight and premature birth (Hillemeier, Weisman, Chase, & Dyer, 2007). Hulme and Blegen examined birth outcomes using a three-level categorization similar to RUCAs. Women in rural communities had worse birth outcomes than those in urban or rural-adjacent counties, with women in rural-adjacent counties found to have the best outcomes. The researchers

asserted that if analysis had been based on a dichotomous rural / urban distinction, the differences between the two rural groups would have been missed (Hulme & Blegen, 1999).

Research examining residency and birth outcomes frequently identifies risk factors also associated with the incidence of low birth weight and premature births. Examples are Wells' research, which associated rural residency with inadequate weight gain during pregnancy, and Luo's work reporting increased association of low levels of maternal income and education with small for gestational age and premature births (Luo, Wilkins, & Kramer, 2006; Wells, Schwalberg, Noonan, & Gabor, 2006). Hillemeir stated that residency should be considered a potentially important predictor of preterm birth and low birth weight (Hillemeier, Weisman, Chase, & Dyer, 2007).

Residency status frequently carries with it risks, with not all risks more prevalent in rural areas. Racial differences in rural vs. urban birth outcomes were examined in a large study conducted in Washington State. Rural dwelling American Indian/Alaska Native (AI/AN) women had higher low birth weight and premature birth rates than Caucasian urban dwelling women, which is consistent with much of the research examining residence; however, rural AI/AN women's low birth weight rate was *significantly lower* than the low birth weight rate of urban dwelling AI/AN. The premature birth rate for rural AI/AN was also lower than that of urban AI/AN, although the difference was not significant. After controlling for other factors, including history of prior pregnancy, adolescent age, use of prenatal care, and maternal smoking, the difference in low birth weight risk between rural and urban groups was not statistically significant, leading the researchers to surmise that most of the variation was due to risk

profiles and not evidence of protective factors associated with urban vs. rural dwelling (Grossman, Krieger, Sugarman, & Forquera, 1994). More recent research using a large data set corroborated the early findings that urban dwelling American Indians (AIs) had significantly higher rates of low birth weight births than rural dwelling AIs and Caucasians (L. Baldwin et al., 2002).

Education.

Educational attainment is associated with improved birth outcomes, including lower incidences of low birth weight and premature births. When compared to women who had some college, women with less than a high school education were significantly more likely to have a premature birth. Differences between high school and non-high school graduates have also been reported (Gazolla et al., 2007; Luo, Wilkins, Platt, & Kramer, 2004). One exception noted was the increase of low birth weight births attributable to medical problems; one possible explanation for this difference may be that women with more education give birth at older ages, and poor birth outcomes may be attributable in part to older maternal age(S. Moore et al., 2004)

Marital Status.

Changes in social mores have diminished the bias against out-of-wedlock birth (Schorr & Schorr, 1988). Marriage was once regarded as an indicator associated with improved financial security and social support. However, marital status is of questionable value as an indicator in today's society. Marriage may be delayed due to employment or education, and non-marital status may not be reflective of committed relationships offering what were once considered benefits of marriage such as financial support. The incidence and reporting of divorce and remarriage may also blur the ability to assess the

effect of marriage per se on health outcomes (Telfair, 2005). Yet, if used in conjunction with other demographic indicators, marital status serves to help identify risk, including the risks of low birth weight and premature births.

The rate of birth to unmarried (single, never-married, divorced, or widowed) women aged 15 to 44 years continues to increase, from 29.4 per thousand women in 1980 to 46.1 per thousand women in 2004. Over one-third (35.8%) of births in the United States were to unmarried women in 2004. Women between 20 and 24 years of age had the highest rate of births among unmarried women at 72.5 births per thousand, compared to a rate of 6 per one thousand in women 40 to 44 years of age (J. Martin et al., 2006). In 2004, 11.1% of the births to unmarried women in the U.S. were low birth weight, compared to 7.5% of the births to married women. In the same time period, 17.09% of the births to unmarried women were premature, compared to 12.77% of the births to married women (NCHS, 2007a).

Payer Source.

The provision of prenatal care through health insurance or Medicaid clearly has benefits for birth outcomes. Medicaid is a major payer for prenatal care and deliveries in the U.S., financing approximately 40% of the births in the nation each year (Kaiser, 2006). Almost two decades ago, a small study in Arizona revealed that women without health insurance had babies with lower mean birth weights than mothers whose births were paid by Medicaid or private insurance (Schwartz, 1990). A more recent study reported that Medicaid clients had fewer premature infants than non-Medicaid clients, with the improved outcomes attributed in part to wrap around services, including case

management, that were covered by Medicaid but not by many private insurers (Guillory, Samuels, Probst, & Sharp, 2003).

According to Buescher and Ward, the nature of the setting in which prenatal care is provided may also affect birth outcomes. They found that Medicaid-insured women who received prenatal care in private settings were more likely to have low birth weight births than those Medicaid-insured women receiving care from public health departments. The difference was attributed to the provision of more comprehensive wrap-around services, including health education and nutrition, to low income women in public health settings (P. Buescher & Ward, 1992).

Race/ethnicity.

In the United States, infant mortality, low birth weight, and premature births disproportionately affect ethnic groups. The risk of low birth weight birth in African American women and American Indian women was over twice that of Caucasian women, even when controlling for medical history, prenatal care, education, and other demographic factors (Kistka et al., 2007; Luo, Wilkins, Platt, & Kramer, 2004; Michielutte et al., 1992). Several explanations have been offered for these disparities, including differences in socioeconomic status (SES). However, several studies report that high SES African American women still have higher infant mortality than low SES non-Hispanic Caucasians and Mexican American women in the populations studied (Collins, Schulte, & Drolet, 1998; McGrady, Sung, Rowley, & Hogue, 1992). Another explanation offered is that racial minorities may have higher incidence of "risky behavior" during pregnancy, including tobacco and alcohol, contributing to poorer birth outcomes. However, several studies have contradicted this assumption, including one that reported that low income African

American women had more low birth weight and premature births than low income Caucasian women with similar risk factors (R. Goldenberg et al., 1996).

A third explanation was that delayed and inadequate utilization of prenatal care by minority women contributed to poorer birth outcomes. The continued lack of evidence regarding the effect of prenatal care on low birth weight and prematurity makes this explanation questionable as well (M. Lu & Halfon, 2003). Large studies continue to confirm that disparity exists, independent of maternal medical and SES factors (Kistka et al., 2007).

Several issues confound the analysis of the impact of race on low birth weight and preterm birth outcomes in non-White populations. There is a higher incidence of bacterial vaginosis and chronic hypertension in African American women (J. Martin et al., 2006; Meis et al., 2000). There is also a high rate of domestic violence against American Indian women (Bohn, 2002). Physiologic reaction to stress may vary by ethnicity, pointing to the need for further study to identify predictive models that may explain the ethnic differences in the rates of preterm births (Ruiz, Fullerton, Brown, & Dudley, 2002).

In the United States in 2004, over three-fourths (78.4%) of births were to Caucasian mothers, 14.9% to African American mothers, 5.6% to Asians or Pacific Islanders, and only 1% to American Indians (J. Martin et al., 2006). The picture in Montana is much different: 85.3% of births were to Caucasian mothers, only 0.5% to African American mothers, 1% of births were to Asians or Pacific Islanders, and 13.2% of births were to Americans Indians (DPHHS, 2005). American Indian births constitute a much higher percentage of births in Montana than in much of the U.S. Several studies reported the low birth weight rate in the U.S. American Indian population as almost twice

that of the Caucasian population (Grossman et al., 2002; Grossman, Krieger, Sugarman, & Forquera, 1994). In Canada, the low birth weight rate of Inuit and North American Indian women was lower than that of a referent French speaking group. North American women also had lower risk of preterm birth, although Inuit women had a higher risk of preterm birth than the referent group. In fact, North American Indian women were reported as having the lowest low birth weight rates, the highest proportion of large for gestational age (> 4500 g) babies, and the most births occurring after 41 weeks gestation. Further analysis led the investigators to conclude that risks of low birth weight and preterm births were higher among unmarried and less educated women in all ethnic populations, and that these factors were of greater import than ethnicity when considering disparity issues (Luo, Wilkins, Platt, & Kramer, 2004).

Summary of Demographic Factors

Research presents strong evidence for older maternal age and non-Caucasian race as risk factors for preterm and low birth weight births. Marital status and education continue to be valuable as socioeconomic indicators, specifically in the absence of other indicators such as income. As such, unmarried status and low education are risk factors for poor birth outcomes. Residency in rural settings presents risk due to limited availability of prenatal care. Demographic variables are rarely amenable to change, but can be useful for public health planning and service delivery. In the current research study, demographic variables were used in conjunction with medical and behavioral risk factors to develop a matched cohort of women for comparison of those receiving home visiting to those not receiving services.

Medical Risk Factors Predating Pregnancy

Maternal health prior to conception affects the course of the pregnancy and pregnancy outcomes (Kermack, McKendrick, & McKinlay, 2001). Behaviors negatively impacting overall health and illness may exist prior to a pregnancy, yet have devastating affects on outcomes. Availability of data regarding medical risk factors predating pregnancy has been limited, but expanded birth certificate data and retrospective surveys provide documentation of risk factors that places a pregnancy at risk even before conception. This section summarizes major medical risk factors predating pregnancy.

Low Maternal Weight

Research on the effect of pre-pregnancy weight on pregnancy outcomes has examined the associations between both maternal weight at the time of conception and outcome measures, including low birth weight and premature birth. A common measure of weight is body mass index (BMI), which is calculated as weight in kilograms divided by the square of the height in meters (Baeten, Bukusi, & Lambe, 2001). Variation in the categorization of weights or BMI's as underweight or "lean," normal, and overweight makes comparisons across studies difficult. The Institute of Medicine defined four categories for pre-pregnancy BMI: underweight < 19.8; normal = 19.8 to 26.0; overweight = 26.1 to 28.9; and obese ≥ 29.0 (IOM, 1990a, , 1990b). These categories are not always used, and may be modified slightly by the creation of subcategories such as "very" obese. The referent group also varies, with some researchers using normal weight women as the referent group and others using low weight or "lean" women.

Women who have a low BMI are at greatest risk for premature and low birth weight births. Haas and associates reported that women who were underweight (defined as BMI of ≤ 18.5) had the highest risk of all weight groups for delivering a preterm

infant. Underweight women were more than twice more likely to have a premature baby than normal weight women (BMI = 18.5 – 24.9). Their analysis included modeling that adjusted for confounding variables such as socio-demographic characteristics and pre-pregnancy health status. In all models, the risk of premature delivery continued to be greatest for underweight women as compared to all other weight groups (Haas et al., 2005). In a large study examining the interrelationships of pre-pregnancy BMI and weight gain during pregnancy, Dietz and colleagues reported that underweight women (BMI < 19.8) had increased risk for delivery of both moderately preterm (32 to 36 weeks gestation) and very preterm (20 to 31 weeks gestation) infants, compared to normal weight women (BMI = 19.8 to 26). Underweight women with low weight gain (0.12 kg/wk) during the second and third trimesters had the highest risk for delivering a preterm infant compared to all sub groups reported, including normal, overweight (BMI = 26.1 to 28.9), and obese (BMI ≥ 29) women (Dietz et al., 2006).

Obesity

Obesity in the U.S. has reached epidemic proportions (Baeten, Bukusi, & Lambe, 2001; Sukalich, Mingione, & Glantz, 2006). The obesity level of child bearing aged women has increased along with the population as a whole. The percent of obese women between 20 and 44 years of age has quadrupled from 7.2% for the two year period between 1960 and 1962 to 28.4% for 1999 through 2002 (NCHS, 2007a). Almost one-third of adolescent females from 12 to 19 years of age had a BMI ≥ 30.5, and 15.4% of all females in this age group were at or above the ninety-fifth percentile. The incidence of obesity among women of child bearing age differs between racial / ethnic groups, with

non-Hispanic white women having the lowest (30.7%) incidence and non-Hispanic Black women having the highest (49%) (Hedley et al., 2004).

Maternal obesity negatively affects pregnancy outcomes, resulting in the greater risk for preeclampsia and gestational diabetes, caesarean delivery, and/or delivery of a macrocosmic infant (Baeten, Bukusi, & Lambe, 2001; K. Rosenberg, 2005; Sukalich, Mingione, & Glantz, 2006). The mechanisms to explain the association between maternal obesity and premature delivery are not fully understood, with co-morbidities of sedentary lifestyle, gestational diabetes, preeclampsia and ecclampsia confounding analysis.

Several researchers have found that obese women have higher risks for preterm births as compared to normal weight women. Obese women were 60 to 80% more likely to deliver a premature infant compared to normal weight women (Baeten, Bukusi, & Lambe, 2001; Cnattingius, Forman, Berendes, Graubard, & Isotalo, 1993; Haas et al., 2005; Hellerstedt, Himes, Story, Alton, & Edwards, 1997). The association between obesity and prematurity is not, however, reported by all researchers; Rosenberg and associates (2005) reported that very obese women with prepregnancy weight ≥ 300 pounds had a lower incidence (AOR = 0.88) when compared to all other weight groups. Further, the incidence of preterm birth was lower (AOR = 0.54) in women with high weight gain (≥ 41 pounds) compared to those who gained forty or fewer pounds (T. Rosenberg, Garbers, Lipkind, & Chiasson, 2005).

The incidence of low birth weight birth in obese women is not consistently reported. Co-morbidities of diabetes and hypertension, more frequently found in obese than normal weight women, and confounded analysis is due, in part, to the higher incidence of macrosomic infants in diabetic mothers (Baeten, Bukusi, & Lambe, 2001).

In fact, overweight adolescents may be less likely to have a low birth weight or small for gestational age (OR 0.8) infant than the normal weight adolescents (Sukalich, Mingione, & Glantz, 2006).

Hypertension/Chronic Hypertension

The associations between hypertension in pregnancy and low birth weight and between hypertension and premature birth are well established in the literature (R. Goldenberg & Culhane, 2007; McCowan, Buist, North, & Gamble, 1996; Montan, 2007; Ray, Vermeulen, Shapiro, & Kenshole, 2001). Hypertension as a pre-existing condition is usually labeled as chronic hypertension, and is diagnosed based on the detection of blood pressure at 140/90 mm Hg (Cunningham et al., 2005). Hypertension can result in decreased perfusion and inadequate blood flow to the fetus, resulting in less than optimal growth and potential early parturition. Chronic hypertension can occur in all age groups, with nulliparous older women at higher risk for chronic hypertension. In the United States, the prevalence of chronic hypertension in pregnant women is increasing, from a rate of 6.5 per 1,000 live births in 1990 to 9.6 per 1.000 live births in 2004 (J. Martin et al., 2006).

The incidence of low birth weight and premature births associated with hypertension are further impacted by obesity, chronic and acute disorders, nutrition, and racial / ethnic origin. The prevalence of hypertension during pregnancy has been found to be highest for African Americans and lowest for Caucasians (Fang, Madhavan, & Alderman, 1999). In addition to finding a significant association between hypertension and low birth weight, Madan and colleagues found higher risks in Asian Indian and Mexican populations, both U.S. born and foreign born, compared to the U.S. born

Caucasian population (Madan et al., 2006). In a recently published population-based study, Graham and associates found a higher risk for low birth weight and premature births in Caucasian women with chronic hypertension in Mississippi compared to African Americans. These findings are dissimilar to previously reported findings and deserve further evaluation (J. Graham, Zhang, & Schwalberg, 2007).

Diabetes

Diabetes is one of the most commonly reported medical complications of pregnancy, predisposing women to complications including caesarean deliveries, large or macrosomic infants (> 4000 grams), fetal congenital malformations, and preterm deliveries (El Mallah, Narchi, Kulaylat, & Shaban, 1997; Ray, Vermeulen, Shapiro, & Kenshole, 2001; T. Rosenberg, Garbers, Lipkind, & Chiasson, 2005). The incidence of diabetes in pregnancy was 35.8 per 1,000 live births in the U.S. in 2004 (J. Martin et al., 2006). The diagnosis of diabetes is based on laboratory and clinical findings, including a random plasma glucose level > 200 mg/dL or a fasting glucose exceeding 125 mg/dL, clinical symptoms including polyuria and weight loss. Detection of symptoms may be difficult in pregnancy due to the physiologic changes occurring in the woman. Diabetes may be categorized as pregestational or overt (present prior to pregnancy) and gestational. Pregestational diabetes may also be further categorized as Type 1 diabetes, attributable to defective insulin secretion, or Type 2, attributable to insulin resistance or inability to effectively utilize insulin (Cunningham et al., 2005). Preexisting (Type 2) diabetes not detected until pregnancy may be erroneously labeled gestational diabetes (Moum et al., 2004; T. Rosenberg, Garbers, Lipkind, & Chiasson, 2005).

The incidence of preterm birth is higher in women with diabetes than in women without diabetes. In 2004, the preterm birth rate in women with diabetes was 17.5% compared to 12.3% in those without diabetes (NCHS, 2007a). Pregestational diabetes, also reported as Type 1 or chronic diabetes, places women at especially high risk for premature birth. Rosenberg reported the adjusted odds ration for preterm birth in women with chronic diabetes at 2.54 compared to 1.28 for those with gestational diabetes (T. Rosenberg, Garbers, Lipkind, & Chiasson, 2005). Lepercq similarly found that women with Type 1 diabetes are four to eight times more likely to have a preterm birth than women with out diabetes (Lepercq, Coste, Theau, Dubois-Laforgue, & Timsit, 2004). Diabetic women, especially those with pregestational diabetes, are also at increased risk of having a low birth weight infant (Nicholson et al., 2006). Racial disparity also exists; Moum reported that American Indian (AI) women in Montana had higher incidence of diabetes in pregnancy than the Caucasian population, although the reported incidence of diabetes increased for both groups over the last two decades (Moum et al., 2004).

History of Poor Pregnancy Outcome

A history of poor birth outcome is an important risk factor in subsequent pregnancies (Chandiramani & Shennan, 2006; Hillier et al., 1995; Mackey, Williams, & Tiller, 2000; Sclowitz & Santos, 2006; Steer, 2005). In 2004, 80% of U.S. birth certificates included a response regarding maternal history of a previous preterm or small for gestational age birth. Only 1.1% of the birth certificates reported a history but, of those, 32% had a preterm delivery and 24% had a low birth weight birth, compared to 12% and 8% respectively for those mothers whose birth certificate indicated they did *not* have a history of previous poor outcome (NCHS, 2007a).

Reports of history of preterm delivery increase with maternal age (Cleary-Goldman et al., 2005), but maternal age along does not adequately explain the increased risk for prematurity and low birth weight births following previous poor outcomes. Increased risk for premature birth has been reported in second and third births to teen mothers, and in births for younger mothers until aged 25 years (Akinbami, Schoendorf, & Kiely, 2000).

Medical Risk during Pregnancy

Multiple Births

There is a higher incidence of low birth weight and premature births among multiple pregnancies, defined as a pregnancy with two or more fetuses. Multiple pregnancies, accounting for only 3.3% of the live births in the United States in 2004, result in a higher incidence of premature and low birth weight births than singleton pregnancies (J. Martin et al., 2006). In 2002, multi-fetal births accounted for 17% of all preterm births and 24% of low birth weight births (J. Martin et al., 2003). Final birth data for the United States in 2004 revealed that the average birth weight of a twin was 2,333 grams, approximately 1,000 grams lower than the average birth weight of singletons (J. Martin et al., 2006). Moore reported that approximately one-half of all twins and 90% of triplets and higher order multiples are born premature and at low birth weight (M. Moore, 2003).

The number of triplets and higher order multiples in U.S. pregnancies has increased dramatically from an incidence of 37 per 100,000 live births in 1980 to 193.5 per 100,000 in 1998 (J. Martin & Park, 1999). Assisted reproductive technology (ART) includes procedures and treatments involving human oocytes, sperm or embryos, with the intent of

establishing a pregnancy (P. Committee, 2004). ART has contributed substantially to the increase in multiple births. One population-based cohort study of births from 1996 to 1999 found that one-third (33%) of multiple births were attributable to ART or ovulation induction (ACOG, 2005). ART may also result in risk for prematurity and low birth weight separate from the risk of multiple gestation births. From a review of published studies on reproductive outcomes, Mukhopadhaya and Arulkumaran concluded there was a higher risk for preterm birth in singletons conceived with ART compared to naturally conceived singletons, with odds ratios of over 2.5 (Mukhopadhaya & Arulkumaran, 2007). Earlier, Schieve and associates reported that risk for low birth weight was increased not only in twins and higher order multiple births attributable to ART but also in singletons, and recommended further analysis of the effect of ART on the rate of low birth weight births in the United States (Schieve et al., 2002).

Gestational diabetes

Gestational diabetes is defined as any degree of glucose intolerance with onset or first recognition occurring during pregnancy (E. Committee, 2003). As noted earlier, gestational diabetes may be diabetes undetected before pregnancy. A significantly higher risk for premature births has been found for women with gestational and pregestational diabetes compared to a control group, although the risk for women with gestational diabetes was lower than for those with pregestational diabetes. In contrast, the risk for low birth weight births for both women with gestational diabetes and those with pregestational diabetes was lower than the risk of the control population (El Mallah, Narchi, Kulaylat, & Shaban, 1997). Consistent with these findings, a large population-based study revealed that the risk of preterm birth was higher for women with gestational diabetes than women

without diabetes although not as high as in women with chronic diabetes (T. Rosenberg, Garbers, Lipkind, & Chiasson, 2005). Further, the risk of low birth weight birth was lower in women with gestational diabetics compared to those without diabetes and those with chronic diabetes (K. Rosenberg, 2005).

The incidence of gestational diabetes is higher in overweight and obese women (T. Rosenberg, Garbers, Lipkind, & Chiasson, 2005). For women with gestational diabetes, especially obese women, preeclampsia and ecclampsia increase the risk for pregnancy complications, specifically low birth weight and premature births (Baeten, Bukusi, & Lambe, 2001).

Preeclampsia and Ecclampsia

Preeclampsia can be described as a *syndrome*, specific to pregnancy that results in altered organ perfusion associated with vasospasm. Diagnosis of preeclampsia is contingent upon the detection of protein in the urine, at high levels and not limited to a single random test. Urine tests revealing at least 300 mg protein in 24 hours or repeated and persistent measures of 30 mg/dL (1+ dipstick) in random urine samples are considered diagnostic of preeclampsia. Preeclampsia may be asymptomatic but, if accompanied by high diastolic blood pressure ($\geq$ 110 mm Hg), symptoms of headache, visual disturbance, elevated serum creatinine, and thrombocytopenia may occur. Women with chronic hypertension are predisposed to develop preeclampsia, and are at higher risk for negative outcomes, including fetal growth restriction that contributes to the incidence of low birth weight births (Cunningham et al., 2005). Ecclampsia, characterized by convulsions that can not otherwise be explained and the HELLP Syndrome (hemolysis, elevated liver enzymes, and low platelets) are the most serious complications of hypertensive disorders in

pregnancy, with high reported morbidity and mortality rates in both mothers and infants. In the United States, the incidence of ecclampsia has decreased from one in 1150 deliveries between 1983 and 1986 to one in 3250 deliveries in 1998 (J. Alexander, McIntire, & Leveno, 2003; Ventura, Martin, & Curtin, 2000).

Due in large part to delivery being the standard intervention for severe preeclampsia, infants born to women with preeclampsia and ecclampsia are more likely to be premature or low birth weight. In 2004, 42% of births to women with ecclampsia were preterm and 38% were low birth weight, compared to 12% and 8%, respectively, in those without ecclampsia (NCHS, 2007a).

Infection

The occurrence of infection, including genitourinary and periodontal, has been linked to higher incidences of premature births, with more limited associations documented to low birth weight births (M. Lu & Halfon, 2003). Up to 80% of early preterm births (< 32 weeks gestation) are associated with intrauterine infection preceding the rupture of membranes (R. Goldenberg & Rouse, 1998). Moutquin offered an explanatory model of preterm labor that identified urinary tract infection as one of seven risk factors significantly associated with preterm labor and delivery (Moutquin, 1999, , 2003). Goldenberg and Rouse argued that sexually transmitted diseases (STDs) have also been associated with birth outcomes (R. Goldenberg & Rouse, 1998).

Bacterial vaginosis is one of the most frequently reported genital infections, occurring in twelve to 22% of pregnancies (Hillier et al., 1995; Kurki, Sivonen, Renkonen, Savia, & Ylikorkala, 1992). Bacterial vaginosis is not transmitted from partner to partner; rather, changes in the vaginal flora allow an overgrowth of other

bacteria such as *Mobiluncus* and *Gardnernella Vaginalis* (CDC, 2006a). Unfortunately, bacterial vaginosis is associated with higher incidences of premature delivery of low birth weight infants, independent of other risk factors (Hillier et al., 1995). A systematic review of the research revealed that while antibiotics decreased the risk associated with persistent bacterial vaginosis, they did not decrease the risk for premature birth (Okun, Gronau, & Hannah, 2005). Of particular importance to the present study was the finding for chronic maternal stress to be a significant and independent predictor of bacterial vaginosis (Culhane et al., 2001).

Periodontal disease and infection have also been linked to preterm birth and low birth weight (Mills & Moses, 2002). Offenbacher and colleagues first identified the association and reported a seven-fold increase in risk for preterm delivery in those with periodontal disease (Offenbacher et al., 1996). Subsequent research has both confirmed and refuted the finding. Two large studies conducted in the UK found no associations between periodontal disease and premature or low birth weight births (Davenport et al., 2002; S. Moore et al., 2004). However, a meta-analysis of case control and prospective cohort studies concluded that periodontal disease was strongly associated with increased risk for preterm birth (Khader & Ta'ani, 2005). This assertion was supported by a small case control study reporting a significant association between periodontitis and premature births (Radnai et al., 2006). However, a review of ten case control studies and five cohort studies revealed variability in the definitions of poor pregnancy outcomes and periodontal disease, and problematic small sample sizes. The authors concluded that there was insufficient evidence to determine if the link between periodontal disease and preterm and low birth weight births was “causal or coincidental” (Michalowicz & Durand, 2007).

Researchers generally agree that good oral health is supportive of overall nutrition and health that can, in turn, contribute to improved birth outcomes.

Poor Nutritional Status and Inadequate Weight Gain

Inadequate nutrition and poor pregnancy weight gain contribute to higher incidences of premature and low birth weight births (Bitler & Currie, 2005; R. Goldenberg & Culhane, 2007; G. Lu et al., 2001; Siega-Riz, Herrmann, Savitz, & Thorp, 2001). One of the earliest scientific analyses of the association between poor maternal nutrition and the incidence of low birth weight was reported six decades ago and documented a mean birth weight decrease of approximately 250 grams in infants born to women who experienced severe nutritional deprivation during the occupation related famine in the Netherlands (Smith, 1947). For six months during the winter of 1945, occupying forces restricted dietary intake to 600 kcal/day for all civilians, including pregnant women. Stein and colleagues reported that while the average infant weight decrease of 250 grams may have seemed inconsequential, the fetal mortality during that time increased significantly. After the policy implementing the imposed famine was reversed, birth weights rose and fetal mortality again decreased (Z. Stein, Susser, & Saenger, 1975). Researchers continue to examine weight gain and nutrition in relation to birth outcomes, with the most recent weight gain recommendations based on pre-pregnancy weight rather than a standard weight gain recommendation for all pregnant women. The American Academy of Pediatrics and the American College of Obstetricians endorsed guidelines originally developed by the Institute of Medicine in 1990 (Cunningham et al., 2005). The guidelines recommend weight gains from a low of 15

pounds for obese women with BMI ≥ 29 to a high of 40 pounds for women with BMI < 19.8 (IOM, 1990a).

Martin and associates reported that those at greatest risk for delivering a low birth weight infant were women who gained less than 16 pounds during a pregnancy. Despite the clear association, in 2001 one-third of pregnant women had weight gains outside the IOM recommendations (J. Martin et al., 2002). Although fetal weight gain is usually highest during the third trimester, arrested or limited maternal weight gain in the second trimester has the greatest negative impact on overall fetal weight gain, contributing to low infant birth weight (B. Abrams, Newman, Key, & Parker, 1989). Conventional wisdom, supported by research, encourages practitioners to include weight control and nutrition education in their care, ideally before pregnancy as well as during the gestational period, in order to positively impact pregnancy outcomes (Cnattinguis, Bergstrom, Lipworth, & Kramer, 1998).

The USDA Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) identified decreased incidence of low birth weight and premature births as two of the most important program outcomes (USDA, 2006), and research generally documents that the WIC program does contribute to improving those birth outcomes (Bitler & Currie, 2005; P. Buescher & Horton, 2000). However, research has not consistently documented a relationship between nutritional interventions and a reduction of low birth weight or premature births (R. Goldenberg & Culhane, 2007). Poor nutrition in pregnant women is frequently accompanied by other psychosocial and economic factors that also negatively affect birth outcomes. Laraia and colleagues examined the psychosocial and economic factors affecting pregnant women based on their “food

security" status for a 12-month period. Food security was determined by self-reported responses to an 18-question module developed by the U. S. Department of Agriculture (Bickel, Nord, Price, Hamilton, & Cook, 2000). Women who had concerns about food quality and quantity were more likely to be young, poor, less educated (high school or less), African American, and unmarried (Laraia, Siega-Riz, Gundersen, & Dole, 2006). Of particular interest for the present study were the authors' findings that food insecurity measures were associated with higher stress, anxiety, and depression, and lower self esteem; these factors are also associated with poor birth outcomes.

Placenta Previa

Placenta previa is one of several complications of pregnancy that may necessitate surgical intervention (C-section) prior to term gestation, and therefore result in a premature and low birth weight birth. In placenta previa, the cervical os is occluded either completely or partially by the placenta (Cunningham et al., 2005). In 2001, placenta previa occurred in more than 13,000 deliveries with an incidence of about one per 300 births (J. Martin et al., 2002). Placenta previa is more common in older women, women with previous cesarean deliveries and in women with multi-fetal pregnancies, and in women with ART (C.. Ananth, Demissie, Smulian, & Vintzileos, 2003; Cunningham et al., 2005; Gilliam, Rosenberg, & Davis, 2002; Kallen, Finnstrom, Nygren, Otterblad Olausson, & Wennerholm, 2005; Mukhopadhaya & Arulkumaran, 2007; M. Williams & Mittendorf, 1993).

Tobacco use places women at particular risk for placenta previa (C. Ananth, Demissie, Smulian, & Vintzileos, 2001; C.. Ananth, Demissie, Smulian, & Vintzileos, 2003; Chelmow, Andrew, & Baker, 1996). Carbon monoxide hypoxemia related to

smoking was postulated to result in placental hypertrophy that increases the risk of cervical os occlusion, contributing to an increased relative risk of placenta previa in women who smoked at any time during their pregnancy to be twice that of women who never smoked (M. Williams et al., 1991). Anath and associates reported significantly lower birth weights and higher incidence of premature births among women with placenta previa compared to women without placenta previa and, in their sample of over 500,000 mother-infant pairs, 12% of premature births were attributed to placenta previa (C. Ananth, Demissie, Smulian, & Vintzileos, 2001)

Incompetent Cervix

Incompetent cervix is painless cervical dilatation that usually occurs in the second trimester and allows prolapse of uterine contents into the vagina, with consequent spontaneous abortion or premature birth, depending upon viability of the fetus. Treatment of choice for incompetent cervix is cerclage, the placement of sutures to hold the cervix closed. Cerclage is of limited value in changing perinatal outcomes, especially lengthening gestation, although the only alternative strategy is "expectant management" in the form of medical monitoring (Cunningham et al., 2005). In an early study, 13% of cerclage clients had a premature delivery compared to 17% in the non-cerclage group, a statistically significant albeit low level of difference (MacNaughton, Chalmers, & Dubowitz, 1993). More recent studies found incidences of preterm births of 22 - 35% in the cerclage groups, and 26 - 36% in the expectant management groups, leading investigators to conclude that cerclage did not affect perinatal outcomes (Rust, Atlas, Reed, van Gaalen, & Balducci, 2001; To et al., 2004).

Premature Rupture of the Membranes

Premature rupture of the membranes (PROM) is the spontaneous rupture of the fetal membranes prior to 37 weeks gestation and before the onset of labor (Cunningham et al., 2005). Mercer reported that premature rupture of the membranes occurs in approximately three percent of pregnancies and contributes to about one-third of all preterm births. No single cause of PROM has been identified but intrauterine infection is thought to be a major contributor given its diagnosis in nearly one-third of the cases of PROM (Gomez, Romero, Edwin, & David, 1997; Goncalves, Chaiworapongsa, & Romero, 2002; Mercer, 2003; Sclowitz & Santos, 2006). A significantly higher risk for PROM (OR 1.6) has also been found in women with bacterial vaginosis (Ziaei, Sadrkhanlu, Moeini, & Faghihzadeh, 2006).

Other risk factors for PROM include demographic and behavioral factors. There is a higher incidence of PROM in women under 16 years of age, as well as a higher incidence in older women, specifically those over 35 years (B. Abrams, Newman, Key, & Parker, 1989; Berkowitz, Blackmore-Prince, Lapinski, & Savitz, 1998). A meta-analysis of studies assessing substance abuse by pregnant women revealed that cocaine use contributed to the incidence of PROM (Addis, Moretti, Ahmed Syed, Einarson, & Koren, 2001).

Hyperemesis Gravidarum

Hyperemesis gravidarum is defined variably but generally refers to severe nausea and vomiting that extends beyond the first trimester and results in weight loss, dehydration, acidosis (from starvation), alkalosis (from loss of hydrochloric acid in vomitus), and/or hyperkalemia (Cunningham et al., 2005). The “partial starvation” status negatively affects pregnancy outcomes, including presenting a risk for low birth weight birth (Chihara et al.,

2003). Other research confirms that hyperemesis gravidarum increases the risk for women to have both premature and low birth weight births (Crawford, 2002; Dodds, Fell, Joseph, Allen, & Butler, 2006).

Summary of Medical Risk Factors

Medical risk factors predating pregnancy and those occurring during the pregnancy can negatively affect birth outcomes, resulting in higher rates of premature and low birth weight births. Some medical risk factors are not amenable to change and some may only respond to medical intervention, i.e. incompetent cervix and ecclampsia. Some medical risk factors may be improved by education and monitoring, specifically poor nutrition and inadequate weight gain.

Behavioral and Environmental risk

Substance use, environmental risks and psychological influences, including depression, stress due to domestic violence, family conflict, financial concerns and other "social stressors" have been documented to increase the incidence of poor birth outcomes (AHRQ, 2001; Gennaro & Hennessy, 2003; Hedegaard, Henriksen, Sabroe, & Secher, 1993; Kelly et al., 2002; Mackey, Williams, & Tiller, 2000). The relationship of these factors are variably reported, rarely isolated, and frequently identified in conjunction with other medical or social risk factors.

Substance Use in Pregnancy

It is well established that substance use negatively affects birth outcomes. Perreira and Cortes identified five sets of factors that influence substance use during pregnancy: (1) demographic factors, (2) socioeconomic background, (3) psychosocial resources, especially social support, (4) domestic violence and partner substance use, and (5)

maternal stress (Perreira & Cortes, 2006). This section will review substance use behaviors contributing to low birth weight and premature births.

Tobacco use.

The association between tobacco and increased risk for low birth weight and premature birth is well established in the literature (CDC, 2001). Cigarette smoke contains substances that are potentially teratogenic, including nicotine, cotinine, cyanide, carbon monoxide, cadmium, lead, and some hydrocarbons (Cunningham et al., 2005). These substances are harmful directly to the fetus and also cause vasoconstriction that can result in decreased blood flow to and oxygenation of the fetus, which in turn affects fetal growth (CDC, 2004). Tobacco use has been documented to increase the risks for perinatal complications, such as placenta previa, placenta abruption, and premature rupture of the membranes, that in turn contribute to higher incidences of prematurity and low birth weight (C. Ananth, Demissie, Smulian, & Vintzileos, 2001; Andres & Day, 2000; CDC, 2001).

According to birth certificate data, 11.4% of women smoked during pregnancy in 2002, a reduction from 18.4% who smoked during pregnancy in 1990. Younger women were more likely to report smoking during pregnancy: 20.3% of women aged 15 to19 years smoked during pregnancy in 1990, decreasing to only 17.1% in 2002. State level data revealed that tobacco use among pregnant women in Montana is much higher than the national average. Nineteen percent of birth certificates indicated tobacco use during pregnancy in 2002. Of great concern is the very high rate of tobacco use in younger women in Montana. One-third (33.1%) of women aged 15 to 19 years in Montana smoked during pregnancy, an increase from 28.3% in 1990. Only five other states had higher rates

in this age group, and Montana's increase between 1990 and 2002 was higher than the change in any other state (CDC, 2004).

Maternal smoking clearly increases the risk of premature birth. In a 2001 CDC report, *Women and Smoking*, the relative risk for premature birth among smokers compared to non-smokers ranged from 1.2 to 2.0 in the studies reviewed (CDC, 2001). The risk of premature birth associated with smoking increased with maternal age (Cnattinguis, Bergstrom, Lipworth, & Kramer, 1998; Olsen et al., 1995). According to some researchers, the risk is dose related as well, increasing with the number of cigarettes smoked (Meis et al., 1995; Nordentoft et al., 1996; P. Shiono, Klebanoff, & Rhoads, 1986).

The association between maternal smoking and increased risk for low birth weight birth was also reported by the CDC, with risk ratios from 1.5 to 3.5 (CDC, 2001). Risk for low birth weight birth increased with the number of cigarettes smoked, and also increased with maternal age (CDC, 1990; Cnattinguis, Bergstrom, Lipworth, & Kramer, 1998; Eskenazi, Prehn, & Christianson, 1995; McDonald, Armstrong, & Sloan, 1992). Reducing or eliminating tobacco use during pregnancy can improve birth outcomes (CDC, 2001; Cliver et al., 1995). The longer a woman smokes during pregnancy, the more negatively affected the birth weight will be, with smoking in the third trimester especially deleterious to birth weight outcomes (Lieberman, Gremy, Lang, & Cohen, 1994; Zaren, Lindmark, & Gebre-Medhin, 1996). Tobacco cessation efforts *throughout* pregnancy, not only early in pregnancy, can help decrease the incidence of premature births and low birth weight (Dolan-Mullen, Ramirez, & Groff, 1994; Lieberman, Gremy, Lang, & Cohen, 1994).

Although there is limited published research about the affects of smokeless or spit tobacco on pregnancy outcomes, it is important to also consider smokeless tobacco use as

it contains many of the same harmful substances found in cigarettes. Smokeless tobacco products, also known as snuff or spit tobacco, have variable amounts of free nicotine. The CDC reported that, although novice users often start with low nicotine brands, they "graduate" to higher nicotine level brands (CDC, 2000). Nicotine blood levels are higher and more sustained in smokeless tobacco users than in cigarette smokers, with blood nicotine levels measured at approximately 12 mg/dl in chew tobacco users two hours after use, compared to < 5 mg/dl in cigarette smokers (Benowitz, Porchet, & Jacob, 1990). Smokeless tobacco also includes numerous additives, including 28 known cancer causing agents (NCI, 1992). The effect of additives on birth outcomes is not known. Gupta and associates reported that smokeless tobacco use was associated with reductions in birth weight and gestational ages in their prospective study of 1,217 women in India. Women who used smokeless tobacco were more likely to have premature births (OR of 1.4) and low birth weight births (OR 1.6) compared to women who did not use smokeless tobacco (Gupta & Sreevidya, 2004).

The effects of smokeless tobacco on health and pregnancy outcomes are of special concern in Montana where, like other tobacco products, the use is very high. The Youth Risk Behavior Surveillance survey examines health behaviors and trends in the United States. In 2005, 8% of high school students reported being "current smokeless tobacco users" whereas, in Montana, 14.8% of high school students reported being current users - only West Virginia reported higher use at 14.9% of students. Montana also has the second highest smokeless tobacco use reported by female high school students with 5.8% reporting smokeless tobacco use, second only to Wyoming with 5.9% females reporting use (CDC, 2006b). Smokeless tobacco use results in nicotine addiction and dependence,

making the use of nicotine products by young women just beginning their childbearing years a grave concern.

Second hand exposure to tobacco.

Smoking is deleterious not only if the pregnant woman smokes but also if she is exposed to second hand smoke (Davis, Helgerson, & Waller, 1992; M. Moore & Zaccaro, 2000). Recent research has focused on the effect of environmental tobacco exposure on birth outcomes, including paternal and other family member use, as well as work environment exposure. Kharazzi and colleagues reported higher ratios of fetal death, preterm birth, and low birth weight births (OR 3.4, 1.8, and 1.8, respectively) in non-smoking women with high cotinine levels (0.236–10 ng/mL) attributed to environmental smoke, compared to women with lower cotinine levels (<0.026 ng/mL) (Kharrazi et al., 2004). Similarly, women exposed to environmental smoke, based on dose attributed to the number of smokers in the home, were found to have a higher incidence of early preterm delivery (AOR 1.56) (Fantuzzi et al., 2007). Ward and associates also documented an increased risk for low birth weight in women exposed to environmental smoke compared to women who were not exposed, albeit at non-significant levels (Ward, Lewis, & Coleman, 2007).

Alcohol use.

The effect of alcohol use is difficult to ascertain, as alcohol is frequently used in conjunction with other substances, including tobacco and illicit drugs. Alcohol use is also prevalent in women who have other risk factors for premature and low birth weight births, including stress and domestic violence. (AHRQ, 2001; McFarlane, Parker, & Soeken, 1996). Further, women with a history of physical abuse and / or whose male

partner who was an alcohol abuser also had higher risk of alcohol use during pregnancy (Haynes, Dunnagan, & Christopher, 2003; Leonardson & Loudenburg, 2003; Mengel, Searight, & Cook, 2006; Svikis & Reid-Quinones, 2003).

The prevalence of alcohol use in pregnancy is difficult to determine, based in part on the variability in data sources used. In 2004, only two-thirds of the birth certificates filed in the U.S. included a response regarding alcohol use (NCHS, 2007a). The small numbers of women who actually report alcohol use makes the reliability of birth certificate reports questionable (Barnes-Boyd, Fordham Norr, & Nacion, 2001; P. Buescher, Taylor, Davis, & Bowling, 1993; DiGiuseppe, Aron, Ranbom, Harper, & Rosenthal, 2002; Piper et al., 1993; Roohan et al., 2003). The Behavioral Risk Factor Surveillance System (BRFSS), is a telephone survey used to track health conditions and risk behaviors. Adults (18 years or older), including pregnant women, are surveyed about their health risk behaviors, health practices, and health services (BRFSS, 2007). Based on BRFSS data, alcohol use of any amount during pregnancy was 12.4% in 1991, 16.3% in 1995, and 12.8% in 1999. Pregnant women who reported alcohol use were more likely to be over 30 years of age, employed, and unmarried (Sidhu & Floyd, 2002).

The association between alcohol use and premature and low birth weight births is less robust than the association between tobacco use and birth outcomes. The amount of alcohol used during pregnancy and the timing of alcohol use results in various risk. Research quite consistently documents a lower or similar premature birth risk for women who report drinking rarely or moderately as compared to non-drinkers (McDonald, Armstrong, & Sloan, 1992). Albertson and associates reported no difference in the risk of premature delivery for non-drinkers compared to women who drank three or fewer drinks

per week. However, the risk of premature birth increased as the amount of alcohol consumed increased: women who reported drinking four to six drinks per week were only slightly more likely (RR1.15) to have a premature birth, while women who reported drinking seven or more drinks per week had a much higher risk (RR 1.77) (Albertsen, Andersen, Olsen, & Gronbaek, 2004).

The timing of alcohol use during pregnancy also appears to affect the impact on birth outcomes. Lundsberg and associates reported that women drinking very small or moderates amounts of alcohol during the first month of pregnancy had lower rates of premature delivery compared to women who did not drink any alcohol. In contrast, small to moderate amounts of alcohol in the seventh month almost doubled the risk of women to have premature birth when compared to risk of non-drinking women (Lundsberg, Bracken, & Saftlas, 1997). Kesmodel and associates also reported much higher risk ratios found for women who disclosed having ten or more drinks per week in the thirtieth week of gestation (RR 3.56) and in the sixteenth week of gestation (RR 2.93), as compared to women who reported drinking less than one drink per week (Kesmodel, Olsen, & Secher, 2000).

Multi-substance use exacerbates the risk of premature birth. Dew and associates recently analyzed the effect of various substances on the incidence of prematurity using logistic regression, and reported that risk increased as more substances were used. Non-drinkers in the sample had a prematurity rate of 10.1%. The incidence of prematurity increased to 17.3% for women reporting alcohol use, 18%, for those reporting both tobacco and alcohol use, and 20.8% for those reporting alcohol and illicit drug use. The use of all three substances (alcohol, tobacco and illicit drugs) by pregnant women

increased the incidence of prematurity to 31.4% (Dew, Guillory, Okah, Cai, & Hoff, 2007).

Illicit drugs.

Illicit drugs are variably defined but generally may be defined to include drugs not allowed by law or drugs that are used for other than lawful purpose. The Substance Abuse and Mental Health Administration defines illicit drugs to include marijuana or hashish, cocaine, inhalants, hallucinogens, lysergic acid diethylamide (LSD), Ecstasy (methylenedioxymethamphetamine), and heroin. Prescription psychotherapeutics used non-medically (such as stimulants, sedatives, tranquilizers, and pain relievers) are also considered illicit drugs (Larson, Eyerman, Foster, & Gfroerer, 2007). Most illicit drugs are listed in Schedule I of the Controlled Substances Act, which includes drugs with a high potential for abuse and with no accepted medical use. Schedule I drug categories include opiates, opium derivatives, hallucinogenic substances, depressants, and stimulants (CFR, 1973).

The assessment of the impact of illicit drug use on birth outcomes is hampered by the lack of reliable data. Women may be hesitant to report illicit drug use, in part due to possible legal ramifications and custody concerns (Noonan, Reichman, Corman, & Dave, 2007; Savitz et al., 2002). Shiono and associates tested for cocaine metabolites in their study population of over seven thousand pregnant women and detected the metabolites in 93 women. Only 8 of the 93 women had admitted to using cocaine on the self-reported surveys distributed at the time the physiologic testing was conducted and, of those who did report, most stated that they used cocaine only infrequently or had quit using the drug early in their pregnancy (P. Shiono et al., 1995). Kaestener and colleagues also documented

client underreporting in their study, with only 17% of the women who tested positive for illicit drugs at their baby's birth having previously admitted to drug use. The investigators found a higher incidence of low birth weight birth in the group of self-reported drug users compared to the group of users identified by physiologic testing. They surmised that self-reported users may have heavier use than those who do not self-report (Kaestener, Joyce, & Wehbeh, 1996). Noonan and associates recently further documented underreporting of use among drug users; 5% of their study sample admitted to drug use during pregnancy, however, further investigation using prenatal records, hospital records, laboratory data, and provider progress notes, revealed that 9.4% had evidence of prenatal drug use (Noonan, Reichman, Corman, & Dave, 2007).

Illicit drug use in pregnancy certainly increases the risk of low birth weight and premature births. Feldman and associates examined birth outcomes for over 1,000 pregnant women in New York in the late 1980s. Fourteen percent of the participants tested positive for illicit drugs, including cocaine, marijuana, opiates, and methadone. Compared to women not using drugs, women who were drug users had higher incidences of premature (OR 3.34) and low birth weight (OR 2.64) births (J. Feldman, Minkoff, McCalla, & Salwen, 1992). Sprauve and colleagues compared birth outcomes of 483 drug users (as determined by positive urine screen) to those of 3158 non drug users. Those who used drugs were significantly more likely to have a premature birth (28.2% versus 17.1%) and /or to deliver a low birth weight baby (31.3% vs. 14.9%) than non-users (Sprauve, Lindsay, Herbert, & Graves, 1997). Noonan and associates also reported an increased risk for low birth weight birth in drug-using women, with the percent of low birth weight births ranging from 22% for the subset of women using any drugs to 27% for those using "hard" drugs

(defined as other than marijuana); this rate compared to an overall low birth weight rate of 9.9% in the full sample(Noonan, Reichman, Corman, & Dave, 2007).

There are inconsistent findings regarding associations between premature and low birth weight births and illicit drug use. Neither marijuana nor cocaine were found to be associated with the incidence of premature or low birth weight birth rates in several studies of pregnant women (Lasker, Coyle, Li, & Ortynsky, 2005; P. Shiono & Behrman, 1995; Visscher, Feder, Burns, Brady, & Bray, 2003). Several researchers noted that self reported illicit drug use was a limitation to study design.

Summary of Substance Use

Ideally, women should abstain from substance use prior to and during pregnancy. However, since nearly half of pregnancies in the U.S. are unintended (Ahluwalia, Whitehead, & Bensyl, 2007; CDC, 2007; Finer & Henshaw, 2006), the risk for women using substances when they do not know they are pregnant is real. A qualitative study culminated in a series of recommendations for how health providers may best assist women to address their behavioral risks, including substance use. The incorporation of risk assessment for substance use into routine care was one recommendation, hence normalizing the assessment and not stigmatizing users. Providers were also encouraged to use interview techniques that encourage disclosure, to tap into women's sense of accountability or motivation regarding the fetus' and infants' health, to work collaboratively with clients to develop a plan that was owned by the patient, and to involve significant others in supporting and promoting cessation or reduction of substance use. Finally, providers were encouraged to revisit or "chip away" at risks, and to understand that change takes time and requires encouragement (Herzig et al., 2006).

Stress

Associations between stress and health status have been identified for centuries (C. Hobel, 2004). In the early 1940's, Sontag found one of the earliest associations between maternal stress and infant development, documenting an observed relationship between emotional disturbances in pregnant women and feeding difficulties in their infants. He ascribed the feeding difficulties to irritable and hyperactive autonomic nervous development in utero (Sontag, 1947). Subsequent papers further documented the association between stressful conditions (described as maternal employment, poor diet, and/or unmarried status) and increased risk for poor birth outcomes, specifically premature birth (N. Anderson, Brown, & Lyon, 1941; Drillien, 1957).

Stress can affect birth outcomes in several ways. First, stress can negatively affect birth outcomes through physiologic effects that initiate parturition prior to the fetus reaching term, or 38 weeks gestation (Sandman et al., 2006; Sandman et al., 1999; Wadhwa, 2005). Second, stress may negatively affect birth outcomes by decreasing the perfusion of blood to the placenta and fetus, resulting in diminished growth and maturation (Diego et al., 2006). Third, stress has been demonstrated to increase the risk of infection, which in turn can precipitate or contribute to premature birth (Gazolla et al., 2007; Hogue & Bremner, 2005; Mercer, 2003). Last, stress can contribute to maternal behaviors that negatively affect birth outcomes, including tobacco use, substance use, and inadequate nutrition (Curry, 1998; Laraia, Siega-Riz, Gundersen, & Dole, 2006; Little et al., 2005; Perreira & Cortes, 2006).

The definitions and conceptualizations of stress are varied. Newton and Hunt defined stress as a "state anxiety" that reflects a "transitory emotional state or condition of

the human organism that is characterized by subjective, consciously perceived feelings of tension and apprehension, and heightened autonomic nervous system activity" (Newton & Hunt, 1984). They conceptualized anxiety in association with changes in women's life conditions and women's perceptions about those changes. In a meta-analysis, Kramer grouped stressful life change events, anxiety, mental illness and unwanted pregnancy as "maternal psychological factors," akin to stress, affecting metabolic expenditures and catecholamine or hormonal balances in women (Kramer, 1987). Hedegaard and associates defined maternal stress as "psychological distress" that included the incidence of and perception of stressful life events, social network strain, and psychological job strain (Hedegaard, Henriksen, Sabroe, & Secher, 1993). In yet another conceptualization, Ruiz and colleagues defined stress as "any physical or psychological challenge that threatens or is perceived to have the potential to threaten homeostasis," noting that "perceived social support moderates stress" (Ruiz, Fullerton, & Dudley, 2003). Similarly, Hobel defined stress as a "state of threatened 'homeostasis' or loss of balance," with stressors being those disturbing forces that create the imbalance (C. Hobel, 2004). Other researchers conceptualized stress as primarily employment related (Hickey et al., 1995), associated with domestic abuse (Curry, Burton, & Fields, 1998, or as an indicator of inadequate social support {Feldman, 2000 #701).

Measures used to gauge stress vary according to the definitions of stress they are designed to quantify. The assessment of stress sometimes includes the measurement of biochemical indicators of stress, including plasma levels of corticotrophin releasing hormone (CRH), adrenocorticotropin hormone (ACTH), and beta endorphins (Ruiz, Fullerton, Brown, & Dudley, 2002; Sandman et al., 2006; Wadhwa, Dunkel-Schetter,

Chicz-DeMet, Porto, & Sandman, 1996; Wadhwa et al., 2004). These measures reflect the understanding that stress can contribute to early activation of the fetal hypothalamic-pituitary-adrenal axis, leading to premature labor and delivery. The hypothalamic-pituitary-adrenal (HPA) axis is the system of influences between the hypothalamus, the pituitary gland, and the adrenal gland. Early activation of this axis is estimated to account for up to one third of premature births in the U.S. (Lockwood, 2002).

The interaction between the hypothalamus, pituitary gland and the adrenal gland is part of the neuroendocrine system that controls reactions to stress. In the non-pregnant state, CRH is produced and expressed by the hypothalamus: CRH assists in regulating the hypothalamic-pituitary-adrenal (HPA) axis. During pregnancy, the placenta is also a major site for CRH production. Research on animal, primate and human subjects over the last decade has effectively documented that placental corticotrophin releasing hormone (CRH) is involved in the physiology of normal parturition and elevated CRH is a significant predictor for spontaneous preterm birth (Diego et al., 2006; Erickson et al., 2001; Korebrits et al., 1998; Sandman et al., 2006; Wadhwa, 2005). CRH stimulates the production of prostaglandins which in turn stimulate uterine contractions and cervical ripening. Prostaglandins also stimulate the release of CRH in the placenta, creating a feedback loop that not only initiates but also drives labor, even when the labor is premature.

Glucocorticoids inhibit the hypothalamic release of CRH, but stress enhances placental production, in turn stimulating the release of adrenocorticotropin (ACTH) from the fetal pituitary gland, further stimulating cortisol production (Lockwood, 2002). Maternal stress has been reported to increase the release of norepinephrine and cortisol, initiating expression of the placental corticotrophin-releasing hormone (CRH), and further

stimulating the biological cascade leading to preterm labor (C. Hobel, Dunkel-Schetter, Roesch, Castro, & Arora, 1999).Women in preterm labor have high levels of CRH compared to control subjects with similar gestations, and elevated CRH may precede onset of preterm labor by several weeks (Korebrits et al., 1998). Cortisol and other stress hormone production increases in cases of major depression, and these hormones have been documented to facilitate the release of placental corticotropic releasing hormone that in turn triggers labor and parturition (Dayan et al., 2006).

The time that stress occurs during pregnancy has been found to affect the impact on birth outcomes. Maternal plasma level of CRH was found to be significantly elevated by mid-gestation in women who subsequently delivered preterm (C. Hobel, Dunkel-Schetter, Roesch, Castro, & Arora, 1999). Chronic stress, occurring throughout and prior to pregnancy, appears to have greater impact on birth outcomes than acute or episodic stress (Lobel, DeVincent, Kaminer, & Meyer, 2000). Chronic stress and stress occurring after the third trimester appeared to have less impact on the HPA than acute stress occurring in the first or second trimester (C. Hobel, 2004). The effects of the Nortridge (California) earthquake on pregnant women were assessed, revealing that women in the first trimester perceived higher risk associated with the earthquake than women in the second or third trimester (Glynn, Wadhwa, Dunkel-Schetter, Chicz-Demet, & Sandman, 2001).

Another way stress can negatively affect birth outcomes is by increasing susceptibility to amniotic infection or inflammation (Wadhwa, Culhane, Rauh, & Barve, 2001). Both maternal stress and infection have been independently implicated as risk factors for preterm birth, but the research examining the link between stress and infection remains relatively under developed. One of the few investigations that have studied this

relationship found that high levels of maternal psychological stress and low levels of social support were significantly associated with depressed lymphocyte activity, increasing risk for infection (Herrera, Alvarado, & Matrinez, 1998). Another study found that a high level of chronic stress was associated with bacterial vaginosis, independent of other socio-demographic and behavioral risk factors (Culhane et al., 2001).

Stress during pregnancy has been attributed to depression, domestic violence/abuse, changes in or uncertainty surrounding life events or conditions, lack of support, imposed stress (e.g., work-related), anxiety related to the condition of pregnancy, and individual perceptions of stress. Tools used to measure stress depend upon the conceptualization of stress by researchers. Numerous tools are available to measure stress; some of the most frequently used tools include the Abuse Assessment Screen (Curry, Durham, Bullock, Bloom, & Davis, 2006), the Daily Hassles questionnaire (Diego et al., 2006), the Perceived Stress Scale (Laraia, Siega-Riz, Gundersen, & Dole, 2006), the Prenatal Psychosocial Profile (Curry, Burton, & Fields, 1998), and the State Trait Anxiety Inventory (Dayan et al., 2006; Diego et al., 2006). These tools clearly measure different conceptualizations of stress. According to Hobel, the most popular measures of psychosocial stress in pregnancy have been those measuring major life events and state and trait anxiety; however, he noted a more recent shift to measures intended to assess depression and generalized distress (C. Hobel, 2004). Gennaro and Hennessey suggested that combining multiple measures of stress enhanced the likelihood of identifying women at risk for delivering prematurely (Gennaro & Hennessy, 2003).

Sable and Wilkinson reported that the risk of having a very low birth weight was one and one-half times greater for women who reported being “almost always" stressed

during pregnancy. The regression model confirmed that several other factors were also independently associated with the increased risk for low birth weight births, including reconciliations with husbands or partners (OR 1.7) and unhappiness about the pregnancy (OR 1.3) (Sable & Wilkinson, 2000). Women who reported stress related to abuse were more than twice as likely to have a low birth weight birth as women who reported an absence of stress (Altarac & Strobino, 2002).

A qualitative study to explore pregnant women's perception of contributors to preterm labor and birth yielded the generalization that the women perceived that stress was a central contributor. Factors attributed to creating the stress were complex family situations and problematic relationships with partners, especially insensitivity and insufficient contribution to the relationship. The women understood the effects of stress but lacked the skills to manage or negate them. The researchers concluded that a history of chaotic life situations should be recognized as a risk factor for preterm labor, and further recommended that nursing interventions would help women to manage complex lifestyles and implement change that could result in a decreased incidence of premature births (Mackey & Boyle, 2000).

Homelessness

Homelessness is alternatively conceptualized as an indicator of stress, a factor of socioeconomic status, and/or an associated factor in domestic violence and abuse (AHRQ, 2001; Faugier & Sargeant, 1997; Little et al., 2005) The lack of safe and/or affordable housing has been linked to a higher incidence of poor birth outcomes. One study reported that homeless women were twice as likely to have a premature birth and three times more likely to have a low birth weight birth than women with secure housing. In the same study,

17% of babies born to the homeless women were low birth weight, a proportion that is nearly triple the six percent national average (J. A. Stein, Lu, & Gellberg, 2000). Stein and associate's study corroborated findings of a study conducted a decade earlier on women living in temporary housing (Parsons, 1991). These findings were again confirmed in a Canadian study that also examined substance use and homeless women. Homelessness increased the risk of premature delivery by almost three times and the risk for low birth weight births nearly seven times. Substance use further exacerbated the risk to a six-fold increase risk for premature birth and a seventeen-fold increase risk for low birth weight birth (AOR 16.9, 95% CI 3.5–79.3) (Little et al., 2005).

Domestic Violence/Abuse

Women who experience violence or abuse during pregnancy have an increased risk for premature and low birth weight births (Bohn, 2002; El Kady, Gilbert, Xing, & Smith, 2005; Kaye, Mirembe, Bantebya, Johansson, & Ekstrom, 2006). The prevalence of abuse is difficult to ascertain, due both to the variation in the definitions of abuse and the methods used to determine abuse. Abuse includes physical violence (pushing, slapping, hitting, shoving), emotional mistreatment, and sexual abuse (forced sexual acts) (Heaman, 2005; Jasinski, 2004; Kaye, Mirembe, Bantebya, Johansson, & Ekstrom, 2006). One of the most commonly used tools to assess domestic violence and abuse is the Abuse Assessment Screen, which includes questions eliciting information on all three types of abuse. The timing of abuse is also variably reported, contributing the difficulty in determining prevalence. Time periods assessed for domestic violence include during pregnancy, in the year prior to pregnancy, or any time during the woman's life (Jasinski, 2004).

A review of thirteen studies revealed that the incidence of violence during pregnancy ranged from 0.9% to 20.1%. However, the authors concluded that higher estimates of incidence (7.4 to 20.1%) resulted from methodological approaches in which personal interviews were conducted throughout the pregnancy in contrast to the conduct of one interview or use of a single questionnaire. Studies that assessed violence later in the pregnancy (during the third trimester) also yielded higher incidences than those reported early in pregnancy (Gazmararian et al., 1996). This decade old review of literature on pregnancy and domestic violence was recently corroborated by a review of another seventeen studies, in which a wide range of incidence of abuse was reported, with prevalence ranging from 1.5% to 24% (Jasinski, 2004).

The prevalence of abuse also varies by ethnicity. Pertinent to the proposed study, there is a higher risk of abuse in American Indian and Caucasian women. In one study, more Caucasian women (27.8%) reported being abused in the year prior to pregnancy, compared to African American (26.8%) and Hispanic (18.6%) women (McFarlane, Parker, & Soeken, 1996) while another study documented American Indian women as having the highest incidence of abuse in the year prior to pregnancy (Curry, 1998). A Canadian study reported that pregnant Aboriginal women were twice more likely to be abused during the year of pregnancy than were non-Aboriginal women (Heaman, 2005). Discordant findings point to the need for assessment of domestic violence in pregnant women regardless of race/ethnicity. Assessment should include the pre-pregnancy period, as abuse prior to pregnancy is highly predictive of abuse during pregnancy. In a sample of 2,630 new mothers completing the Pregnancy Risk Assessment Survey in North Carolina between 1997 and 1998, seven per cent reported abuse in the year prior to

pregnancy. Of those women who reported abuse in the prior year, nearly two-thirds (59%) reported abuse during the pregnancy, compared to 2% of those who had not experienced abuse in the year prior to the pregnancy (S. Martin, Mackie, Kupper, Buescher, & Moracco, 2001).

Domestic abuse is associated with other risk factors. Some may be due to the physical trauma resulting from sexual assault. Women experiencing physical abuse during pregnancy have higher risk for preterm labor, placental abruption, and vaginal and kidney infections (Rachana, Suraiya, Hisham, Abdulaziz, & Hai, 2002).

Increased social support during pregnancy may "be protective of women who are being abused" and enhance pregnancy outcomes (Gielen, O'Campo, Faden, Kass, & Xue, 1994; Renker, 1999). Accordingly, these and other researchers have been led to recommend interventions offering social support during pregnancy (Curry, 1998; McFarlane, Parker, & Soeken, 1996).

Maternal Employment

"Working motherhood" has become the norm in the U.S. rather than a rarity. In 1960, fewer than one in five mothers (18.6 %) with children under age six was in the labor force (Leibowitz, Klerman, & Waite, 1992). By 2006, nearly two thirds (58.7%) of women over sixteen years of age were in the U.S. labor force and, in two thirds of families with children under six years, both parents are employed (Census, 2006). Women's right to work is protected by the Pregnancy Discrimination Act of 1978, which specifically outlines the rights of women to be hired, promoted, or retained on a job whether she is or may become pregnant (USC, 1978). The Act prohibits employers from treating pregnancy differently than other "temporary medical disabilities;" it is telling that

the interpretation does indeed refer to pregnancy as a "disability." Unlike most industrialized countries, the U.S. does not mandate that employees receive paid maternity leave and health benefits. Unfortunately, this means that pregnant women have not only the right to work but often must work to continue their health insurance benefits.

The Family and Medical Leave Act (FMLA) passed in 1993, offered position protection to women for up to twelve weeks (BHP, 1993). However, a report to Congress revealed that many women do not take the leave, presumably, at least in part, because the leave is without pay unless the woman has accumulated enough sick and/or vacation leave (Dodd, 1996). Many women may choose to save the leave they have accumulated to use after the birth, despite potential risks. For example, over 27% of the 1635 women studied in Georgia who reported that they worked also reported that they were advised to stop working. The most frequent reasons women reported for being advised to stop working were hypertension, vaginal bleeding, and labor – all risk factors for premature delivery. More than half of the women were instructed to stop working before the seventh month of gestation (Frazier, Golbeck, & Lipscomb, 2001).

Work fatigue has been associated with premature and low birth weight birth. A meta-analysis was conducted by Mozurkevich and associates to examine the association between working conditions and pregnancy outcomes; specifically, preterm birth, hypertension, preeclampsia, and small for gestational age births. Twenty-nine studies conducted between 1977 and 1998, reflecting data from 160,988 women, were included in the analysis. The researchers used a modification of an occupational fatigue index developed by Mamelle and associates that provided the assignment of a quantitative score to the type of work activity being performed. The index included measures of posture

(sitting or standing), work on industrial machines, physical exertion, mental stress, and working environment. The possible score ranges from 0 to 5, with zero being the lowest fatigue level and five being the highest (Mamelle, Laumon, & Lazar, 1984). Mozurkevich reported that physically demanding work, prolonged standing, shift and night work were all significantly associated with preterm birth, and that high cumulative work fatigue scores (defined as a score of 3 or greater) were most significantly related (Mozurkewich, Luke, Avni, & Wolf, 2000).

The time spent working has been associated with the incidence of low birth weight births, with women who worked full time (40 hours per week) more likely than women working fewer hours to have a low birthweight delivery (Peoples-Sheps et al., 1991). The degree of physical exertion also affects the incidence of low birth weight birth (Hanke, Kalinka, Makowiec-Dabrowska, & Sobala, 1999; Homer, Beresford, James, Siegel, & Wilcox, 1990; Nurminen, Lusa, Ilmarinen, & Kurppa, 1989; Spinillo et al., 1996). Using a modification of Mamelle's index, the odds of having a low birth weight infant have been found to be increased with each additional occupational condition, including night hours, shift work or irregular scheduling, standing, lifting loads, noise, and high psychological demand combined with low social support. The odds ratio for women experiencing four to six of these conditions was 2.29 (Croteau, Marcoux, & Brisson, 2006).

Some researchers dispute the associations between maternal employment and preterm and low birth weight births. Moss and Carver examined a stratified random sample of 9953 live births occurring in 1988 from forty-eight states, the District of Columbia, and New York City. They reported that the working women in their sample

were more likely to be non-Hispanic white, married, and of higher income and education, and to have medical insurance and be of lower parity. Their findings revealed that these employed women were less likely to have preterm or low birth weight births than non-employed women, although their data sources did not allow examination of variables such as timing of work, stress at work, or the availability of social support (Moss & Carver, 1993). Another study examined risk factors, including maternal employment, for prematurity and low birth weight in a sample of 943 African American and Caucasian women in Alabama. They found no significant relationship between employment and premature or low birth weight births in either race (Hickey et al., 1995). The inconsistency of the findings has been attributed to the limited scope of data sources, including recall and memory biases in retrospective and questionnaire studies, socio-demographic and behavioral risk factors, and incomplete or imprecise descriptions of work and the work environments (Launer, Villar, Kestler, & de Onis, 1990). Gabbe and Turner conducted a review of literature on the topic of the impact of work during pregnancy on perinatal outcomes, reporting that "some studies have shown an unfavorable impact on pregnancy, most notably on preterm labor and birth weight, an equal number have not" (Gabbe & Turner, 1997).

The impact of work on pregnancy outcomes is of particular concern in Montana where the workers, including women, are likely to hold multiple jobs, thereby increasing the likelihood of work fatigue as described in the literature. The number of women in Montana who hold more than one job has almost doubled since 1970, with women being more likely than men to have at least two jobs (2006a; , 2006b). Montana has the nation's largest gender-wage gap in the U.S., with women earning only 67 cents for every dollar

earned by their male counterparts (Turner & Eldredge, 2005). The likelihood of holding multiple jobs in Montana is greater for low wage earners, with more than 30% of workers earning between $5,000 and $15,000 working more than one job (Turner & Queen, 2006). The gender wage gap contributes to the need for women to work multiple jobs, and potentially places them at risk for consequences of prematurity and low birth weight.

The effect of employment on pregnancy outcomes has resulted in legislative action in some countries, including Poland and Canada, where the hours and type of work pregnant women may perform is controlled. Polish law limits pregnant women to perform only light work (defined in legislation as work-related energy expenditure below 700 kcal/shift), while Canadian women in the province of Quebec may request to be reassigned if their working conditions present a danger to themselves or the fetus (Croteau, Marcoux, & Brisson, 2006; Makowiec-Dabrowska, Hanke, Radwan-Wlodarczyk, Koszada-Wlodarczyk, & Sobala, 2003; Makowiec-Dabrowska, Radwan-Wlodarczyk, Kozada-Wlodarczyk, Siedlecka, & Wilczyski, 1998)

Hazardous exposures in work settings

Paul and Kurtz reported that 20 million U.S. workers have been exposed to hazardous materials that may negatively impact reproduction. Exposures include chemicals and biohazards that may enter the body through inhalation, skin absorption, or ingestion. Pregnancy effects are dependent upon not only the type and amount of exposure, but the timing during gestation that exposure occurred (Paul & Kurtz, 1990). An increased incidence of low birth weight births was found for workers exposed to aromatic hydrocarbons (paint thinners, laboratory agents, and cleaners used in food establishments and hospitals), and to anesthetic gases, including halogenated gases and

nitrous oxide (used in medical, veterinary and dental practices) (Giacoia, 1992). Exposure to polychlorinated biphenyls (PCB) has also been associated with low birth weight and premature births, with negative effects increasing with PCB level, even after adjusting for maternal age, parity, gestational age, smoking, and alcohol use during pregnancy (Patandin, Koopman-Esseboom, de Ridder, Weisglas-Kuperus, & Sauer, 1999). More recently, a slight albeit significant association was found between PCB exposure and low birth weight, but only at very high concentration levels (Karmaus & Zhu, 2004). More recent studies both refute and support the associations to poor birth outcomes between PCB levels and birth weights or length of gestation (Khanjani & Sim, 2007; Longnecker, Klebanoff, Brock, & Guo, 2005). Although the use of PCB in appliances and fixtures was halted in 1977, PCB has a long retention in the environment and can be transmitted to humans through their ingestion of foods (fish, meat, and dairy products) that have been contaminated with the substance (ATSDR, 2000; Sagiv, Tolbert, Altshul, & Korrick, 2007).

Exposure to hazardous compounds related to location of residence

Exposure to air pollution has been identified in the literature as another potential risk factor for premature and low birth weight births. The biologic mechanism linking air pollution to preterm birth is as yet unknown, but disturbances of the pituitary-adrenocortico-placental system and uterine blood flow, as well as an increase in maternal susceptibility to infections, may explain at least some of the association (Ritz, Yu, Chapa, & Fruin, 2000). Wang and associates reported a significant relationship between maternal exposures to sulfur dioxide (SO_2), especially during the third trimester, and low infant birth weight. (X. Wang, Ding, Ryan, & Xu, 1997). Bobak found that exposure to SO_2, and to

total suspended particles increased the likelihood of premature and low birth weight births, especially if the exposure occurred during the first trimester (Bobak, 2000). A large study in Southern California of births between 1989 and 1993 found that exposure to particulate matter and carbon monoxide increased the risk of preterm birth, based on the level of exposure. Particulate exposure during the last trimester resulted in the highest increased risk, with carbon monoxide exposure in the first month of pregnancy having the lowest associated increased risk at (Ritz, Yu, Chapa, & Fruin, 2000). Other investigators have since found that exposure to common air pollutants, including carbon monoxide, sulfur dioxide, and nitrogen dioxide, was associated with prematurity and low birth weight, even at relatively low levels of exposure (Liu, Krewski, Shi, Chen, & Burnett, 2003). Significant increases in the incidence of preterm births have also been found for women exposed to fine particulate matter in the air, which includes particulates associated with forest fires (Huynh, Woodruff, Parker, & Schoendorf, 2006).

In 2006, three measuring stations in Montana had the highest carbon monoxide levels the Environmental Protection Area that encompasses Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming. Further, two of the measuring stations in Montana were sulfur dioxide levels that were among the ten highest in the region (EPA, 2006).

Montana's primary industries of mining and agriculture place childbearing aged and pregnant women at risk for exposure to pesticides and hazardous wastes, due to environmental contamination rather than occupational exposure. A small but statistically significant decrease in birth weight ($p = 0.02$) related to exposure to synthetic pyrethroids, a commonly used household and agricultural insecticide, has been reported for women

exposed in the first or second trimester (Hanke, Romitti, Fuortes, Sobala, & Mikulski, 2003). Further, women exposed to pesticides including organophosphates, ureas, triazines, synthetic pyrethroids and N-phenylamides (anilides) in their first or second trimester, delivered infants with birthweights 189 grams lower, on average, than those of infants of matched non-exposed women (Dabrowski, Hanke, Polaska, Makowiec-Dabrowska, & Sobala, 2003). A study designed to examine the effects of exposure to pesticide and strenuous work on the incidence of premature and low birth weight births in Poland, attributed higher incidences of low birth weight births more to strenuous work than to pesticide exposure (Jurewicz, Hanke, Makowiec-Dabrowska, & Sobala, 2005).

Montana's mining and agricultural industries place women in the state at risk both due to employment in those fields and to exposure by living near hazardous areas. Montana has fifteen Superfund sites, more than Wyoming, South Dakota and North Dakota combined (EPA, 2007). Superfund sites are identified by EPA as the "worst hazardous waste sites" in the country, presenting risks to the surrounding communities. Contaminants at these Superfund sites include lead, arsenic, hydrocarbons, and other substances which have linked to premature and low birth weight births (Bell, Ebisu, & Belanger, 2007; Chen, Pan, & Wang, 2006; Faust, 1993; Kaji & Nishi, 2006; Lin, Hwang, Marshall, & Marion, 1998) (NIH, 2007). Montana's Superfund sites are clustered in the central portion of the state in counties where fifty-nine per cent of Montana's population resides (DPHHS, 2006).

Summary of Behavioral and Environmental Risk Factors

The complex and variable nature of poor pregnancy outcomes do not present easy or simple responses to decreasing the incidence of premature and low birth births.

Research has typically focused on individual risk factors and interventions, only recently shifting to consider the social and environmental factors, including stress. In order to decrease the incidence of poor pregnancy outcomes, there is agreement among experts that efforts must be population-based and multifaceted.

Modifiable risk factors include smoking, maternal weight gain, and stress. Effective intervention with these factors, if addressed during the prenatal period, may result in improved outcomes, including fewer premature births and higher birth weights.

Interventions That May Affect Low Birth Weight Or Prematurity

The risks that may affect birth outcomes, specifically low birth weight or prematurity, are complex, including medical, behavioral, and environmental factors. A variety of risks require a variety of approaches to address them, and prenatal care, social service programs, and home visiting programs are some of the mechanisms used to address and hopefully mitigate risks.

Prenatal Care

Care of pregnant women in the US was initially standardized and organized by social reformers and nurses in the early 1900s; nurses visited the homes of pregnant women, providing education and assessment, as part of the home delivery service in Boston in 1901 (Meckel, 1998; Merkatz, Thompson, & Walsh, 1990). Pregnancy and childbirth are managed as medical conditions in industrialized society (Perkins, 2004). Prenatal care and labor and delivery services are a major piece of the business and economics of health care in the U.S.; there were almost 20 million prenatal care visits to physicians offices in the U.S. in 2001, making prenatal care the fourth leading reason for seeking health office visits to physicians (Cherry, Burk, & Woodwell, 2003; Cunningham

et al., 2005). Over four million women were hospitalized in the U.S. in 2004 for childbirth, with an average hospital stay of 2.6 days; childbirth was the most frequently cited reason for hospitalization of women. Newborn hospitalizations also account for a large number of hospital days in the U.S.; over 40% of newborns had one or more illness or risk related diagnosis reported in 2004, with perinatal jaundice, respiratory conditions, and disorders related to prematurity the most commonly reported conditions (Kozak, DeFrances, & Hall, 2006).

The maternal mortality rate in the U.S. dropped from 607.9 maternal deaths per 100,000 live births in 1915 to 12.1 deaths per 100,000 live births in 2003 (Hoyert, 2007). The infant mortality rate is down from 47 deaths per 100,000 live births in 1940 to 6.89 deaths per 100,000 live births in 2005 (Kung, Hoyert, Xu, & Murphy, 2007). Medical management in the form of prenatal care is credited with much of this dramatic improvement, and early and continuous prenatal care has been embraced in the U.S. as an effective way to improve pregnancy outcomes (Thompson, Curry, & Burton, 1998). However, there are many who question the purported association between prenatal care and improved pregnancy and birth outcomes (G. Alexander & Kotelchuck, 2001; Gregory & Davidson, 1999). Fiscella reviewed the literature on prenatal care and pregnancy outcomes published from the mid 1960s through the mid 1990s, and reported that "current evidence does not satisfy the criteria necessary to establish that prenatal care definitively improves birth outcomes" (Fiscella, 1995). Kogan and associates also examined the effect of prenatal care, reporting that increasing use of prenatal care in the 1980s and 1990s accompanied increasing rates of low-birthweight and preterm births (Kogan et al., 1998). Other research strongly supports the association between prenatal

care and improved maternal and infants outcomes; in a large study examining over fourteen million births, women who did not receive prenatal care were almost three times more likely to have a premature birth than women who did have prenatal care (Vintzileos, Ananth, Smulian, Scorza, & Knuppel, 2002). These findings were corroborated by Herbst and associates, who found that women receiving no prenatal care were almost twice as likely to have a low birth weight birth and more than twice as likely to have a premature birth compared to women who had any prenatal care at all (Herbst, Mercer, Beazley, Meyer, & Carr, 2003).

The U.S. Public Health Service impaneled a group of experts to define and describe the content of prenatal care in the mid 1980s. In a report entitled "Caring for Our Future: The Content of Prenatal Care", the expert panel described three basic components of prenatal care, including (1) early and continuing risk assessment, (2) health promotion, and (3) medical and psychological intervention and follow up (DHHS, 1989). The committee's recommendations included several changes to existing practice. The committee recommended that care should begin pre-conceptually, and advised that pre-conceptual counseling be included in any "routine" visit for all women of "reproductive-age." The committee also recommended that the timing and frequency of prenatal visits should be individualized and adjusted to patient risk and needs, and that multiparous women have fewer visits than first time pregnant women, unless risk assessment revealed the need for additional visits.

The recommended number of visits ranged from seven to nine visits during the pregnancy (not including the pre-conceptual visit), considerably fewer than the 13 to 15 visits recommended in the Perinatal Standards of Care developed and published by the

American College of Obstetricians and Gynecologists and the American Academy of Pediatrics in 1983 (AAP/ACOG, 1983). The expert panel also questioned the need for an accelerated visit schedule in the last trimester of pregnancy, and advocated for standardized data collection to facilitate communication between care providers and evaluation of quality of care and patient outcomes (Behrman, 1992; Gregory & Davidson, 1999).

The relationship between prenatal care and adverse birth outcomes, specifically the incidences of low birth weight and premature births has been examined from primarily two perspectives, the first being adequacy of care based on the number and timing of visits, and the second examining the content of care provided (White, Fraser-Lee, Tough, & Newburn-Cook, 2006). While several researchers conclude that the incidence of low birth weight and premature births are higher in women who receive no prenatal care compared to variably defined adequate prenatal care (Herbst, Mercer, Beazley, Meyer, & Carr, 2003; Vintzileos, Ananth, Smulian, Scorza, & Knuppel, 2002), other researchers have documented that decreasing the number of visits from the ACOG recommended number of fourteen visits does not negatively affect birth outcomes. McDuffie and associates reported no significant increases in the incidences of low birth weight or premature births among women randomized to an experimental nine visit schedule following the Expert Panel recommendations compared to a matched cohort assigned to the standard 13 to 15 visit schedule (McDuffie, Beck, Bischoff, Cross, & Orleans, 1996). Partridge and Holman concurred with earlier findings, finding that decreasing the number of visits from 10.9 to 9.2 resulted in no denigration of maternal or neonatal outcomes, including low birth weight and premature births, and no decrease in

patient satisfaction with care received (Partridge & Holman, 2005). Gregory and associates reviewed the available literature from 1997 to 2005, and concluded that the incidence of preterm and low birth weight births are not negatively affected by reduced frequency visits as outlined by the Expert Panel (Gregory, Johnson, Johnson, & Entman, 2006).

Research regarding the adequacy of the content of prenatal visits and the relationship between poor birth outcomes reveals that women who do not receive recommended advice including adequate and appropriate nutrition and avoidance of substance use were more likely to have a low birth weight or very low birth weight infant (Kogan, Alexander, Kotelchuck, & Nagey, 1994; Sable & Wilkinson, 2000). Prenatal care does not necessarily include the full array of services recommended, with one study reporting that 92% of subjects reported receiving the recommended medical procedures, 70% received information about coping and stress and signs of symptoms of premature labor and only 58.6% received advice about the risks associated with tobacco, drug and alcohol use. The premature birth rate in the subjects not receiving information about signs and symptoms of premature labor, was two times higher than women who did receive that information (White, Fraser-Lee, Tough, & Newburn-Cook, 2006).

The average length of an office visit to an obstetrician/gynecologist or a family practice physician in the U.S. in 2005 was about 19 minutes (Cherry, Woodwell, & Rechtsteiner, 2007). Seventy six percent of women in the U.S. received between 9 and 16 prenatal visits in 2005, resulting in about 3 to 4 hours of contact over the course of the pregnancy (NCHS, 2007a). This is a very limited amount of time to address the complex

array of factors and conditions that can and do contribute to premature and low birth weight birth outcomes.

One approach to improving prenatal care that has demonstrated positive influence on birth outcomes is “Centering Pregnancy”, which is an alternative to traditional prenatal care (Rising, 1998). Centering Pregnancy is a group approach to providing prenatal care, utilizing medical, social, and support service providers and programs. Practices utilizing the Centering concepts recruit pregnant women into the group program at their first prenatal visit. Groups include 8 to 12 women and their partners; the groups have similar gestational ages, and begin meeting as a group at about 12 to 16 weeks gestation. The group meets for approximately two hours at each appointment; one author noted that the approach to care provided approximately 20 hours of contact between clients and care providers (Carlson & Lowe, 2006). Centering pregnancy follows a prenatal schedule similar to the schedule recommended by the Expert Panel, and provides the opportunity for exchange and support throughout each visit and the course of the pregnancy (Rising, 1998). A randomized controlled trial revealed that the group of women in the Centering Pregnancy program had significantly higher average birth weights than the women receiving traditional prenatal care. Infants of group patients were also less likely to be low birth weight, although this finding was not statistically significant (Ickovics et al., 2003).

Health Promotion and Social Service interventions

Some federally supported programs in the U.S. can help address the factors that contribute to low birth weight and premature births. The Temporary Assistance for Needy Families (TANF) program is not designed to target health outcomes, but provides

financial assistance to families which may help improve the nutritional status of the family and decrease stress associated with finding affordable housing (Bender, 2003; HICGC, 2007). The Healthy Start program is a more targeted effort to: provide adequate prenatal care; promote healthy prenatal behaviors, including substance abuse prevention and reduction; meet basic health needs, including nutrition, housing, and psychosocial support; reduce barriers to health care; and empower women to manage their own health care (Association, 2006). The goals of the Healthy Start Program and the Healthy Start Association specifically include reduction of "infant mortality, low birthweight and racial disparities in perinatal outcomes" (Association, 2006).

Healthy Start program evaluations do document decreased infant mortality rates in the target populations; success is attributed to client education on breastfeeding promotion, smoking cessation during pregnancy, perinatal substance abuse, and family planning, and referrals to public health home visiting programs and WIC (Lane et al., 2001). A recent evaluation documented that Healthy Start contributed to a decrease in the infant mortality rate in American Indian communities in the Twin Cities (Minneapolis and St. Paul) area, from a pre-project rate of 19.42 (1996-1998) to 7.97 (2002-2004) (MCHB, 2007). Healthy Start projects have also documented decreased incidences of low birth weight births in the client populations. In 1994, the Baltimore Healthy Start project reported a very low birth weight rate of 2.0% in singleton births in the client population, compared to a citywide rate of 3.7%. In the same year, the Fresno California Healthy Start reported a rate of 9.9% among African American project clients, compared to 14.9% for all African Americans in the project area (MCHB, 2007).

The Special Supplemental Nutrition Program for Women, Infants and Children (WIC) targets high risk women and has goals that include low birth weight reductions. The WIC program is a federal federally-funded, state-run program that provides nutritional education, screening and referral to health services and supplemental food to pregnant, postpartum and breastfeeding women, infants and children up to age five years. WIC participants must be income eligible (less than 185% of poverty) and nutritionally "at risk", including medical risks such as anemia, being underweight, history of pregnancy complications or poor pregnancy outcomes, and "diet based" risks attributed to inadequate diet due to access and income (USDA, 2006). Supplemental foods distributed by WIC vary from program to program and individual to individual, and are based on dietary needs. The WIC program promotes breastfeeding, but women choosing not to breastfeed are provided free infant formula; the program is sometimes criticized for this policy, with protagonists complaining that distribution of formula is a disincentive to breastfeeding (Kent, 2006).

Evaluation of the WIC program is challenging for several reasons. WIC populations are often compared to the general population. Since WIC clients are identified based on the indicators of nutritional risk, there is selection bias by inclusion of women with medical factors which place women at higher risk for poor birth outcomes. Some research compares WIC clients to eligible, non-served clients but eligibility is typically based on income only because data regarding medical risk is often unavailable. Because of the selection bias, WIC clients often do not appear to fare well, with higher rates of low birth weight and prematurity than comparable populations.

An often referenced study on WIC effectiveness is a GAO study that statistically combined the results of seventeen studies, and concluded that women who received WIC services had 25% fewer infants born at low birthweight compared to WIC eligible non-recipients (GAO, 1992). More recent research by Cole and Fox also reported that infants born to WIC clients had significantly lower mean birthweights and were more likely to be low birth weight when compared to infants born income eligible non-recipients or to higher income ineligible women. The researchers qualified these findings by noting that the WIC population differed significantly from the comparison population based on maternal age, number of live births (contributing to lower interpregnancy periods), and tobacco use (Cole & Fox, 2004). Bitler and Currie concurred with this earlier research, finding WIC clients to have significantly fewer low birth weight or premature infants compared to WIC eligible non recipient women (Bitler & Currie, 2005). However, Joyce and associates reported no differences in birth weights between WIC participants and income eligible non-participants in their large study in New York (Joyce, Gibson, & Colman, 2005).

WIC provides screening for and referral to other health services. The variety of WIC service locations results in similarly wide variety of services available in the areas surrounding WIC clinic site. In Montana, the largest clinics in the state are located in the largest communities, with populations of approximately 100,000, serving approximately three thousand clients per month. In contrast, the smallest clinic serves approximately one hundred and eighty clients per month, in multiple sites, due to the very small communities and general scarcity of population (WIC/DPHHS, 2007). The supportive services available for referral in the large communities are extremely varied and robust,

but understandably less sophisticated and developed in small communities. Therefore, the benefits of referral services may be limited in rural settings. In Montana, WIC clients with socioeconomic, medical and behavioral risks beyond the scope of the nutritionally focused WIC program may be referred to a public health nurse. In many communities around the state, the public health nurse is joined by other professionals to provide the services of a public health home visiting program to high risk pregnant women and infants.

Home Visiting

Medical and health promotion services have been provided in clients homes for centuries. The development of home visiting services in the U.S. can be traced back to England, where lay persons visited the homes of the poor and ill to provide care (Gomby, Larson, Lewit, & Behrman, 1993). Florence Nightingale developed training programs in England to prepare nurses and lay people to visit sick people in their homes in 1860 and, in 1861, the Liverpool system of district nursing began, directed and inspired in part by Ms. Nightengale (Lewis, 2007).

Visiting nurses became part of the system of social support developed to care for immigrants and the poor in the U.S., with special focus on problems associated with urban living and immigration, including poverty, contagious disease, and infant mortality (Wasik, 1993). Visiting nurse associations and community-based efforts like the Henry Street Settlement in New York, founded by Lillian Wald in 1895, sprang up across the country, often focusing on maternal and child health and communicable disease prevention (Keeling, 2006). Government involvement also helped drive the need for health services that expanded home visiting due in part, according to Meckel, that health

reformers redefined infant mortality as not necessarily a problem of poverty, but more due to "untutored motherhood." The strategy to address this lack of knowledge was to send nurses into the homes to educate immigrant women about how to care for their infants (Meckel, 1998).

The Children's Bureau, visualized in part by Lillian Wald, was created by President Taft in 1912 and charged with monitoring infant mortality, birth rates, orphanages, juvenile courts, and other issues affecting women and children in the U.S. (ACF, 2007). The Sheppard-Towner Maternity and Infant Protection Act, passed by the U.S. Congress in 1921, increased the number of nurses involved in home visiting by designating funds for visiting nurses and clinic services for pregnant women and infants. Hundreds of nurses were hired by public health agencies to provide home visiting services across the nation; Meckel reports that almost 300,000 home visits were made to mothers and their children in the U.S. in 1925, primarily attributable to funding from the Sheppard-Towner Act (Livingston, 2002; Meckel, 1998).

Abrams attributed some of the development of the public health nurse workforce to economic necessity during the depression in the late 1920s and 1930's, noting that as the economy degenerated, the demand for governmental intervention increased. Roosevelt's "New Deal" formalized partnerships between government agencies and community charities, voluntary associations, and public health nursing agencies, targeting populations at greatest need, including those who were unemployed and with families (S. Abrams, 2007). Public health nurses, albeit with limited training and direction, were charged with improving the health of children by visiting families in their homes. Aid for

Dependent Children, passed by Congress in 1936, further formalized the governmental role in improving the health and welfare of children (SSA, 2007).

With this varied background, and for a variety of purposes, home visiting became a commonly used tool for addressing maternal-child health problems in the United States in the 20th century. Home visiting services to mothers and their children in the mid 20th century were primarily intended to provide information and instruction to families, directing them in how to care for their infants, including those with special needs (Wasik, 1993). Programs developed in the 1980s often targeted pregnant women, with stated goals of improving maternal and newborn outcomes, including reducing low birth weight and infant mortality (D. Olds, Sadler, & Kitzman, 2007). The structure and delivery of home visiting programs are diverse, with different goals, target populations, program content or curricula, service providers, and frequency and intensity of interventions; however, the support for home visiting services persisted, as evidenced by the recommendation by the Select Panel for the Promotion of Child Health to increase funding for home visiting services for high risk prenatal clients and infants (*Better Health for Our Children: A National Strategy* 1981).

Limited evaluation of programs was conducted, although early research demonstrated promising results for improved child health. Gutelius and Kirsch's 1975 study targeted first time unmarried African American women in a low income area in Washington DC. Half of the ninety-two subjects received public health nurse visits in the prenatal period and until the child's third birthday; the content of the visits included counseling and education regarding infant physical, mental, and emotional development. The researchers noted that the first group of experimental mothers received more contact

with their visitors, as well as group encounters in a "club" at a child health center; due to limited staffing, the second group did not receive the intensity of visits or the group encounter. Children in both experimental groups had significantly higher intelligence quotient scores as measured with the Standford-Binet Intelligence Test; the authors credited the higher scores to scores contact with visitors and, while recognizing experimental limitations, stated that they believed that "it is not possible to give underprivileged mothers too much help and support of the right kind" (Gutelius & Kirsch, 1975). This strong belief in the need for support and encouragement of pregnant women and young families continues to be a basis of many of the home visiting programs serving families today.

Olds is perhaps one of the most well known researchers on the subject of nurse home visiting in the United States. Olds' work was reportedly stimulated by his work at a child care center in Baltimore in the 1970s, where he worked with children whom he characterized as receiving care that was "often too little and too late" (NFP, 2007). Olds and colleagues conducted a randomized clinical trial of first time mothers in Elmira, New York, in which women were assigned to one of four groups. The first group received no services through the research project, the second received free transportation to and from prenatal and well child visits, the third group received home visits by nurses during pregnancy, and the fourth group received home visits by nurses during pregnancy and through the child's second birthday. Infants born to all women received sensory and developmental testing up to two years of age.

Olds hypothesized that nurse visiting could improve social support, health habits, and health status ultimately improving birth outcomes, including gestational ages and

birth weights. Nurse visits consisted of three basic activities: parent education, support system enhancement, and referral services. Study outcomes revealed no overall treatment effects for birth weight or length of gestation, although the young adolescents (14 to 16 years of age) had babies who weighted an average of 400 grams heavier than young adolescents in the comparison group. Nurse-visited women had significantly fewer kidney infections and smoked significantly less than the comparison group and, in the women who smoked, those who had nurse visits had significantly lower rates of preterm births than the comparison group who also smoked. The authors concluded that positive program effects were evident in infants born to young adolescents and smokers who received nurse visits (D. Olds, Henderson, Tatelbaum, & Chamberlin, 1986).

In 1987, the U.S. Congress created the National Commission to Prevent Infant Mortality. The Commission was mandated to develop a national strategy for reducing the incidence of infant mortality and morbidity in the U.S. (Chiles, 1989). The Commission published a report in 1989, titled "Home Visiting: Opening Doors for America's Pregnant Women and Children." The report identified home visiting as a potential tool to address the problem of infant mortality and other poor pregnancy outcomes, and called for research to document the effects of the service strategy (NCPIM, 1989). The Opening Doors report stimulated a number of studies using home visiting as a service delivery mechanism intended to address infant and maternal health outcomes, family functioning, parenting, and child development.

Program summaries and systematic reviews of research primarily on research from the 1980's revealed a broad array of purported benefits of home visiting, including improved birth weights in select subgroups, primarily adolescents and smokers, improved

utilization of medical services, and decreased reports of child abuse and neglect (Chapman, Siegel, & Cross, 1990). A systematic review of eight studies revealed adequate evidence that public health nurse visits facilitated positive changes in mothers' attitudes, parenting, and health practices in six of the studies; the remaining two provided no evidence of treatment effect (Combs-Orme, Reis, & Ward, 1985). Cilaska and colleagues reviewed seventy-seven studies, reporting on nine of the studies that were ranked methodologically "strong" and five that were ranked "moderate" based on pre-selected criteria. Thirteen of the 14 included significant benefits for mothers and/or infants on outcomes related to physical or mental health, maternal and child development, health habits, or service utilization. There were no reported negative effects of home visiting (Ciliska et al., 1996). A review of nineteen randomized trials by Olds and Kitzman offered methodological guidance; the authors concluded that the most successful home visiting programs were based on ecological models, used nurses as home visitors, and targeted families at greatest risk rather than offered universal services (Olds & Kitzman, 1990).

Research in the 1990s primarily examined the impact of home visiting on outcomes that included improved birth weight and gestational age, use of prenatal care and other health services, and drug utilization by the mother. Most of the studies initiated home visits in the prenatal period but, of those, few initiated very early in the pregnancy. Villar and associates conducted a randomized clinical trial of home visiting provided to women in Latin America who were at risk for low birth weight. The intervention group received four to six prenatal home visits by nurses or social workers providing "psychosocial-support." There were no significant differences between the intervention and control groups in the

occurrence of low birth weight births, premature deliveries or maternal and neonatal morbidities (Villar et al., 1992).

Bradley and Martin examined the utilization of prenatal care, WIC, Medicaid and food stamp programs by low income women in Indianapolis, Indiana who received home visits from registered nurses, social workers, and paraprofessionals compared to low income who did not receive home visits. They reported that women who received home visits enrolled in health services earlier and attended appointments more consistently than those not visited (Bradley & Martin, 1994).

A randomized clinical trial published by Black and associates compared the self-reported substance use and attendance to medical appointments by drug abusing women who did and did not receive home visits by a nurse. They reported that drug abusing women who received home visits were marginally more likely to report being drug free, and more likely to attend scheduled prenatal and postnatal medical visits (Black et al., 1994).

Two studies reported in 1995 and 1996 examined data on birth outcomes of women who received no services vs. received WIC services vs. received WIC and public health nurse visits. One study reported no significant differences on low birth weight or premature births between the groups (Zotti & Zahner, 1995). In the second study, Baldwin and Chen reported no relationships between the timing of initial public health nurse contact or the number of nurse contacts and subsequent birthweight, yet also reported an additive effect of public health nursing and physician visits on subsequent birthweight and gestational ages (K. Baldwin & Chen, 1996).

A retrospective study of pregnant adolescents examined the initiation and adequacy of prenatal care in relation to the incidence of low birth weight and premature births between a group who received home visits by trained paraprofessionals (Resource Mothers) and a group that did not have home visits. Young women receiving home visits initiated prenatal care earlier and attended visits more consistently. No significant differences in the incidence of low birth weight births were noted between the groups with one exception; married adolescents had fewer premature births than unmarried adolescents (OR 1.22). The investigators reported improvements in the rate of very preterm birth (<33 weeks gestation) for unmarried teens, and a lower incidence of very low birth weight births in women receiving home visits, although these differences between groups were not statistically significant (Rogers, Peoples-Sheps, & Suchindran, 1996).

Olds and associates published several studies in the 1990s that encouraged a shift of the focus of home visiting from primarily birth outcomes and health care utilization to addressing life course changes and socio-emotional development in mothers and their offspring. A follow-up study on the women receiving nursing home visiting services in Elmira, New York in the 1980s assessed outcome measures, including safety and quality of the home environment, stimulation of language skills in infants and young children, maternal warmth, incidence of substantiated abuse, and child intelligence. Whereas there were no differences in the incidences of reported abuse and child intelligence, they found safer home environments for those families receiving home visits, and fewer incidences of physician and emergency room visits, especially those attributed to infant and child injury. Mothers who received home visits were found to be less controlling and their home

environments had more educational toys and books than non-home visited mothers (D. Olds, Henderson, Kitzman, & Cole, 1995).

In 1997, Olds and associates published a fifteen-year follow-up to the Elmira study. Women who received home visits were significantly more likely to delay future pregnancies, and were less likely to experience behavioral impairment related to alcohol and drug use, and less likely to be arrested. Home-visited women also used significantly fewer public resources, as measured by enrollment in welfare (AFDC) programs (D. Olds et al., 1997). The researchers concluded that home visiting had long-ranging effects that positively affected the maternal and child life courses.

Black and associates conducted a small sample randomized clinical trial, and reported marginal improvements in maternal substance use, compliance with primary care appointments, and stimulation of infants. An initial improvement in infant developmental outcome, as measured by the Bayley Scales of Infant Development, was not sustained at eighteen months of age (Black et al., 1994). Kitzman and associates replicated the Olds study in Memphis, Tennessee, and reported that women in the intervention group had fewer subsequent pregnancies, fewer closely spaced pregnancies, longer intervals between births, and fewer months of AFDC and food stamp usage than women in the control group (Kitzman et al., 2000). Despite the qualified assessment of home visiting, researchers continued to encourage the practice of home visiting, reporting “cautious optimism” regarding the potential of home visiting for improving the health and development of women and children (Black, Dubowitz, Hutcheson, Berenson-Howard, & Starr, 1995).

Reviews of the research conducted in the 1990s further documented inconsistent findings and outcomes related to home visiting. Elkan and associates summarized the

findings of six previous reviews in their exhaustive systematic review of home visiting research, concluding that the number of well controlled and conducted studies were limited, and that published studies frequently had small samples, yielding insufficient power. The lack of theoretical framework for many studies, lack of congruence between identified client needs and service, and sketchy descriptions of the content of home visits further complicated their efforts to evaluate effectiveness. The authors questioned the conclusions reached by some of the reviewers that the greatest benefits of home visiting services were to high risk clients, noting that since most research targeted high risk populations, there was a dearth of data on home visiting to low risk clients, thereby providing limited findings upon which to base such a conclusion. Methodological limitations also reduced the confidence of the authors in conclusions that home visiting by nurses is more effective than home visiting by other professionals or para-professionals, and that higher intensity of visits equates to improved outcomes (Elkan et al., 2000).

A recent review of eighteen studies conducted between 1986 and 2001 questioned the conclusion that social support interventions were associated with the reduction of premature and low birth weight births, noting that systematic review demonstrated that social support was significantly associated only with increased incidence of pregnancy termination (RR 2.96) and a decreased incidence of Cesarean section birth (RR .88) (Hodnett & Fredericks, 2007). A synthesis of twenty experimental and quasi-experimental home visiting studies revealed that home visits by nurses had more consistent effects on maternal well being, maternal-child interactions, and parenting than on child health outcomes or health care use. The researchers concluded that home visiting by nurses had

greater effect than visiting by paraprofessionals, echoing the assertions of Olds and Kitzman (Kearney, York, & Deatrick, 2000).

Research on home visiting since 2000 has focused on mother-child interactions, maternal and child life course outcomes, and social network development. Some researchers have also continued to examine the effects of home visiting on infant mortality reduction and neonatal and post-neonatal health, as well as the ongoing question about preferred team structure. Barnes-Boyd and colleagues examined the effects of nurse-only versus multidisciplinary team home visiting, with teams comprised of community workers/advocates who received special training, and were supervised by public health nurses who also attended visits with the advocates at one, six, and twelve months. Unlike many home visiting programs, most mothers entered the program after birth, although 17% initiated services before delivery, typically in the third trimester. Significant improvement in retaining the mother and family in the program and significantly higher incidence of fully immunized children were reported in the team visited group compared to the nurse-only visited group. No significant differences in the incidence of infant mortality and neonatal or post-neonatal morbidity were reported (Barnes-Boyd, Fordham Norr, & Nacion, 2001). The authors reported that team development was a "greater challenge than anticipated", reinforcing the researchers' assumption that visitor training is a crucial component of program success, overcoming negative experiences reported by other programs that included high turnover, absenteeism, and poor performance of para-professional workers (Barnes-Boyd, Fordham Norr, & Nacion, 2001).

Brooten and associates reported decreased infant mortality, fewer preterm deliveries, and fewer prenatal hospitalizations and infant re-hospitalizations for women who received home visiting services by master's-prepared home visitors in addition to routine office-based prenatal care received by both the control and intervention groups. Notably, this study also examined estimated cost savings, an aspect of home visiting evaluation frequently lacking in other studies. The investigators reported that the charges for the advanced practice nurse services for the intervention group was slightly over two thousand dollars, with the average hospital charges of $6213 for deliveries in the intervention group, compared to $10,196 in the control group. The difference of almost $4,000 per dyad constituted a statistically significant difference of almost 39% in savings for the intervention group. Brooten et. al. concluded that the home based interventions prevented approximately 750 hospital days, and estimated that the cost savings for the 85 women and 94 infants in the intervention group was approximately $2.8 million (Brooten et al., 2001).

The impact of "dose" of visits by public health nurses was examined in a retrospective chart review of women who received four or fewer home visits by nurses compared to those who received between five and nine visits. The adequacy of nutrition, hemoglobin levels, prenatal weight gain, tobacco use, and birthweight outcomes were assessed. Mothers in the "more visits" group had higher average hemoglobin levels and higher average infant birthweights than those in the "fewer visit" group, and the mothers in the "more visits" group were more likely to breastfeed. The investigators did not report if differences were statistically significant, but stated that information gained helped

guide program planning by the county health department providing the services (Fetrick, Christensen, & Mitchell, 2003).

Recently published studies often report on the effect of home visitors by paraprofessionals, due in part to concerns about the cost of home visits by professionals. Two randomized clinical trials are noteworthy; the first examining the impact of home visiting on child care knowledge and skills for a group of pregnant American Indian adolescents, and the second assessing the potential for home visits to improve mother-child interaction, maternal psychological health attitudes, infant functioning and development, and the risk of neglect or abuse among vulnerable populations in the United Kingdom.

In the first study, all participants received home visits by trained paraprofessionals; one-half of the 58 participants were randomized to the intervention group receiving "family strengthening" content. The remaining study participants received home visits focused on breastfeeding education. The study design was unique because community members helped identify what they believed the young American Indian women needed to learn. The curriculum was based on the American Academy of Pediatrics' Guide to Baby Care; program graphics, delivery style and content were modified in response to community input to make the program more culturally appropriate. Primary outcome measures were the levels of parenting and child care knowledge and skills, and the degree of involvement of the young women in their infants' care. The design also included secondary measures of family conflict, cohesion, social support, and maternal self esteem and drug use. Mothers in the intervention group had significantly higher knowledge scores at two and six months postpartum and

significantly higher involvement scores at two months postpartum. Child care skill scores were not significantly different between groups, and the scores indicating higher involvement for the intervention mother group diminished at six months post partum. There were no other statistically significant differences between the groups. Attrition was a major limitation of the study, with almost a third of the intervention group and ten percent of the control group dropping out (A. Barlow et al., 2006).

The second study, conducted in the UK, provided weekly home visits beginning in the first trimester or the early part of the second trimester of pregnancy through the first birthday of the women's offspring. The home visits were based upon the Family Partnership Model, which is intended to promote parent-infant interaction through family support and engagement. The study population was primarily low income Caucasian women with risk factors including mental health problems, inadequate housing, domestic violence and substance use. Outcome measures included mother-child interaction, maternal health attitudes and behavior, infant functioning, and risk of neglect and abuse. Significant improvement in maternal sensitivity and infant cooperativeness was reported; no other significant differences were found between the intervention and control group. The cost per mother/infant dyad was estimated at $6,663 (J. Barlow et al., 2007).

A randomized clinical trial of home visiting to adolescent mothers also examined the effects of home visiting by trained home visitors. A parenting curriculum provided the basis of the intervention, enhanced by targeted efforts to promote use of contraception after delivery, and encouragement to return to school and attend scheduled primary care provider visits. The target population, located in Baltimore, Maryland, was pregnant adolescents aged 12 to 18 years who were primarily low income and African American.

The study participants were randomized to the intervention group who received home visits during pregnancy through the child's second birthday. The home-visited group had significantly higher parenting attitude and belief scores (measured with the Adult-Adolescent Parenting Inventory), and significantly more of the home-visited teens returned to school and graduated by two years postpartum. No other significant differences were reported (Barnet, Liu, DeVoe, Alperovitz-Bichell, & Duggan, 2007).

Olds and associates conducted a study examining the effect of nurse versus paraprofessionals on tobacco use, maternal life course (employment, education, and AFDC use), use of preventive services, and subsequent births to first time mothers. They reported that the nurse-visited group had significantly decreased cotinine levels, fewer subsequent pregnancies, higher employment, and improved interaction between mothers and infants than the group visited by para-professionals and the group receiving no home visiting services (D. Olds et al., 2002).

A randomized clinical trial in Australia examined the effect of home visiting by a midwife in the postpartum period on the incidence of breastfeeding, parental drug use, and compliance with infant immunization schedules. The visitors received detailed expectations for each of the eight home visits that occurred between birth and six months postpartum. The control group received phone calls at two months and a home visit at six months postpartum. No significant differences on parental drug use, immunization rates, or breastfeeding were reported between the groups between the groups (Bartu, Sharp, Ludlow, & Doherty, 2006).

Several recent studies have returned their focus to improved birth outcomes, measured by the incidence of low birth weight and premature births, and infant mortality

rates. Donovan and associates conducted a large retrospective case controlled study examining outcomes among participants in the "Every Child Succeeds Program" serving first time mothers in Cincinnati, Ohio. Based on Olds' Nurse Family Partnership and Healthy Families America models, the program provides home visits by social workers, child development specialists, nurses, or paraprofessionals, starting either during pregnancy (43%) or after pregnancy (57%) and continuing through the second or third year of the child's life. The outcome measure of interest was infant mortality, available from the birth/death matched certificates and presented by the investigators as an appropriate measure, serving as a "tip of the iceberg" indicator of children at risk for suboptimal care, poor health outcomes, disability, and death. The researchers found that infants whose families did not receive home visiting were two and one half times more likely to die in infancy than infants whose families did receive home visiting services (Donovan et al., 2007).

Another study examined the Omaha Healthy Start program that included home visiting by trained community workers/paraprofessionals for its effect on the adequacy of prenatal care, and the incidence of low birth weight birth and infant mortality, and the costs of care. The researchers did not describe the demographics of the sample populations, but presented the program as intending to decrease disparity between African American and Caucasian populations. This study was not randomized but compared outcomes from program participants to those of non-participants in the targeted region, as well as to non-participants in the surrounding county. The report presents findings from 2002, the year the program began, and 2003, the second year of the program. A significantly greater rate of low birth weight birth in the intervention

populations was attributed to the fact that program initiation resulted in many of the women in the first year not receiving services until well into the second trimester of their pregnancy. In the second year of the study, more program participants received adequate prenatal care and the low birth weight rate for all program participants was below that of non-participants in the region and, for black participants, was lower than the rate for all black babies in the surrounding county. Cost analysis based on average hospital charges and average length of stay data revealed that program participants had lower hospital costs for newborn stays than non participants, and that the costs were even lower in 2003 than in 2002. The costs savings for care of participant infants was from 22% to 31% less than the costs of non-participant infants. The authors cautioned against over interpretation of the findings, but surmised that cost savings attributable to the program may be substantial (Cramer, Chen, Roberts, & Clute, 2007).

Studies point out both the limitations and potential of home visiting programs. Gray and colleagues conducted a secondary analysis of Old's study in Denver, Colorado. One of the targeted outcomes identified by Olds and associates was a decrease in subsequent births, especially those within 24 months of the first birth. Gray and colleagues postulated that to reach that goal, active intervention was needed, meaning that content on the availability and use of contraception would be included in the documentation of home visits. They examined records of women receiving services for 24 months after the initial birth and found that while almost all clients received the recommended number of visits prescribed by the Olds model, the repeat teen pregnancy rate increased from 8.3% to 28.1% at 24 months after initial delivery. Record review revealed that teenagers who conceived within the first two years were less likely to have

used contraception than those who did not use contraception. Despite the documentation of non-use of contraception, the researchers found that nurses documented efforts to help teens postpone a second pregnancy in only about 30% of the visit records. The authors concluded that there was great potential to improve the program outcomes by focused attention on the targeted aims of the program (Gray, Sheeder, O'Brien, & Stevens-Simon, 2006).

Alternatively, even minimal home visiting by public health nurses targeting specific issues has been demonstrated to have positive outcomes. French and colleagues reported that brief postpartum home visits by specially trained public health nurses has been demonstrated to improve health behaviors such as continued tobacco abstinence after delivery. In a small prospective, two-group design, home visits were provided to an intervention group of post partum women in Ohio. The content of the visits was a guideline included in the Agency for Health Care Policy and Research (now the Agency for Healthcare Research and Quality) known as the "5As of smoking cessation" (USPSTF, 2003). The intervention group received between one and three home visits in the two months postpartum. The purpose of the visits was to support continued smoking cessation or to initiate cessation if recurrence of smoking had occurred after delivery. Tobacco abstinence was reported to be two times higher in the intervention group than in the control group. The investigators point out that the low cost of the intervention in communities that already have infant home visiting in place would make the service very easy to implement (French, Groner, Wewers, & Ahijevych, 2007).

The Structure of Maternal-Child Home Visiting

After decades of research, even the question of what home visiting is and is not continues to challenge providers and researchers alike. Gomby stated that "home visiting is not a single, specific, uniformly defined service, but rather a strategy for service delivery" (Gomby, Larson, Lewit, & Behrman, 1993). Olds reiterated this perspective, stating that home visiting is not "a monolithic service" but that home visiting programs are "a method of delivering a variety of services that can vary substantially in goals, target populations, service providers, program contents, and clinical methods" (D. Olds, Hill, Robinson, Song, & Little, 2000). Sweet expounded on this statement, describing home visiting as an "umbrella term," and that home visiting is a strategy for delivering a service, rather than a specific intervention. Sweet claims that the foci of home visiting changed around 1965, shifting from primarily health and safety related efforts to more "multifaceted, comprehensive programs that remain in existence today" (Sweet & Appelbaum, 2004).

Purpose and Goals

Home visiting programs for maternal-child populations can be designed to address a myriad of purposes. Gomby and associates identified home visiting services in the 1980s and early 1990s which were intended to prevent poor birth outcomes (low birth weight and premature births, maternal and infant morbidity, and infant mortality), promote child intellectual and social development, promote the early and continuous use of preventive health services, prevent child abuse and neglect, and modify the life course of mothers and families, including promoting education and employment, decreasing the incidence of

subsequent pregnancies and decreasing the use of public services including food stamps and welfare (Gomby, Larson, Lewit, & Behrman, 1993).

Programs in the 1990s continued to address many of the same goals, but some researchers more explicitly included the goals of providing family and parent support, promoting parenting competence, assisting families to be economically self-sufficient, and promoting home environments that would support children's early efforts to learn and be successful at school (Gomby, Culross, & Behrman, 1999). Program goals also addressed by home visiting programs are to create and promote safe and educationally supportive home environments (Black et al., 1994; D. Olds et al., 1997; I. Roberts, Kramer, & Suissa, 1996), decrease environmental risks (Brown, McLaine, Dixon, & Simon, 2006; Chen, Pan, & Wang, 2006; Jelliffe-Pawlowski, Miles, Courtney, Materna, & Charlton, 2006), increase the incidence of breastfeeding (Bartu, Sharp, Ludlow, & Doherty, 2006; C. Bennett et al., 2007; Doggett, Burrett, & Osborn, 2005; Hedges, Simmes, Martinez, Linder, & Brown, 2005; Sheehan, Watt, Krueger, & Sword, 2006), decrease the incidence of parental substance and tobacco use (Bartu, Sharp, Ludlow, & Doherty, 2006; Ciliska et al., 1996; Duggan et al., 2004; French, Groner, Wewers, & Ahijevych, 2007; D. Olds et al., 2004), decrease maternal depression(Barnet, Liu, DeVoe, Alperovitz-Bichell, & Duggan, 2007; C. Bennett et al., 2007; Ciliska et al., 1996; Roman et al., 2007), decrease the incidence of select behavioral problems in children (Kitzman et al., 1997; D.. Olds et al., 2004), and decrease costs associated with medical services (Brooten et al., 2001; Cramer, Chen, Roberts, & Clute, 2007).

Multiple purpose programs, while complex to implement and evaluate, may be more effective than programs targeting a particular goal. Ramey and Ramey (1993)

encouraged the development of programs that are multi-faceted, noting that the health and development of children and families are influenced by multiple factors and are embedded in contexts (biological, developmental, environmental and relational), that are dynamic and interactive (Ramey & Ramey, 1993). For example, programs that offer social support affect not only relational benefits, but may enhance self esteem and encourage positive health behaviors, thereby leading to healthier lifestyles and ultimately decreasing the incidence of and effect of behaviors like inadequate nutrition, poor weight gain, smoking, and substance use in pregnancy (P. Feldman, Dunkel-Schetter, Sandman, & Wadhwa, 2000). And while maternal-child home visiting programs may have multiple goals, most share the common characteristics of sending home visitors into homes in order to help improve the lives of children and their families (Gomby, Culross, & Behrman, 1999).

Many programs initiate home visits in the prenatal period, and include stated goals to improve birth outcomes. Olds' Nurse Family Partnership Program (previously known as the Nurse Home Visitation Program) is one of the most well known and disseminated programs in the U.S., with programs in approximately 270 counties in 23 states, including four statewide programs. The program has three goals: (1) to improve pregnancy outcomes, (2) to improve child health and development, and (3) to improve the economic self-sufficiency of families (NFP, 2007). The program uses registered nurses as home visitors who follow prescribed visit guidelines, focusing on maternal health, quality of care giving, and life course development. Home visits are initiated as early in pregnancy as possible, preferably by the sixteenth week of gestation, and continue through the child's first two years of life; the program does not accept court

assignment of participants, but requires that women voluntarily enroll in the program. At present, no federal funding is directly appropriated for the program; instead, programs are funded by combinations of state and county general funds, Medicaid, MCH Title V Block Grant funding, Temporary Assistance for Needy Families (TANF), Tobacco Settlement Funds, and locally obtained grants and charities. Program costs are estimated at $9,118 per family served; by contrast cost benefits are estimated to be $26,298 per family served, based on savings attributed to observed changes in educational attainment and employment , criminal behavior, substance use, reported child abuse and neglect, teen pregnancy prevention, and public assistance utilization. The resulting cost savings of $17,180 per family served is the highest estimated cost savings for home visiting programs reviewed by the Washington State Institute for Public Policy in 2004 (Aos, Lieb, Mayfield, Miller, & Pennucci, 2004). McNaughton (2004) reviewed research reported between 1980 and 2000 that used home visits to serve maternal-child populations. Six of the thirteen studies reviewed included unfavorable birth outcomes, defined as infant mortality, prematurity and low birth weight as targeted program goals for home visiting programs.

Target populations

Home visiting programs for maternal-child populations are designed to reach a wide variety of populations. Home visiting programs often target women and families identified at being “at risk” for poor pregnancy outcomes, child abuse and neglect, or other negative outcomes. Universal home visiting is a service delivery approach intended to reach all pregnant women or to all infants. Efforts to promote home health visiting for all has been a popular notion in the U.S. and, in 1976, Kempe recommended that every

pregnant woman should be assigned a home health visitor to work with them until the child entered school (Kempe, 1976). The U.S. Advisory Board on Child Abuse and Neglect reprised this recommendation in 1991, in a report entitled "Creating Caring Communities: Blueprint for an Effective Federal Policy on Child Abuse and Neglect," recommending that the U.S. government develop and implement a national home visiting program (*Child Abuse and Neglect: Critical First Steps in Response to a National Emergency*, 1990). The report received limited attention, and the Board lacked both the authority and the funding to implement the program (Krugman, 1993). New South Wales and South Australian governments implemented universal home visiting programs for all new mothers. The programs provide support and education to new parents in a single visit, and are used to screen families for potential enrollment in long term home visiting programs, including the one in Southern Australia that is based upon the Olds model. Both programs are government funded (CYWHS, 2005; Plumridge, 2007).

Some communities in the United States also provide universal home visiting. New York City's Newborn Home Visiting Program provides a single home visit by a trained health worker to all families with a newborn in eleven communities in Brooklyn, the Bronx, and Manhattan. The $3.2 million dollar cost of the program is presently covered by funds from the New York City Department of Health and Mental Hygiene (NYC, 2007). Guillford County in North Carolina also offers a single home visit to all families of a newborn; services are provided by specially trained registered nurses and funded by a county partnership (GCHD, 2007). Both programs offer referrals to long term home visiting programs also offered in the communities.

Many programs target specific populations with particular goals in mind. The Nurse Family Partnership targets low income women who are pregnant and anticipating their first baby (NFP, 2007). The Resources, Education and Care in the Home program (REACH-Futures) serves low income women who are pregnant or postpartum, poorly educated, and primarily young, often first time mothers (Barnes-Boyd, Fordham Norr, & Nacion, 2001). The Resource Mother program also targets pregnant or parenting teens (Rogers, Peoples-Sheps, & Suchindran, 1996). Other target populations include pregnant or parenting illicit drug users (Bartu, Sharp, Ludlow, & Doherty, 2006), and pregnant women identified to be at risk for low birth weight or premature births (Barnet, Liu, DeVoe, Alperovitz-Bichell, & Duggan, 2007).

Home visiting programs also target families after birth. The Hawaii Healthy Start Program is one of many that focuses on families with children up to three years who are identified through screening to be at risk for child abuse and neglect (El-Kamary et al., 2004). Sweet and Applebaum (2004) reported that 6.7% of the 60 programs they included in their meta-analysis provided universal home visiting and that 75% targeted families based on income, medical risk (including physical and mental health factors), maternal age, and behavioral history that indicated risk for child abuse or neglect. They reported that programs targeting families at environmental risk generated higher effect sizes than did those not targeting such families for some outcomes, i.e., child abuse outcomes; however, an opposite pattern was observed for other outcomes, i.e., parenting behaviors. The evidence regarding which population most benefited from home visiting was not conclusive, with the program goals and intervention model confounding the interpretation of findings (Sweet & Appelbaum, 2004).

Visitors

Home visiting programs are provided by public and private agencies, and by professionals and non-professionals. Appropriate selection and training of home visitors is crucial to the success of programs, as is the ability of the home visitors to deliver the program as designed, simultaneously responding to and with families as they experience change and crises in their day to day lives. Byrd (1997) examined characteristics of effective home visiting in her qualitative review of child-focused home visits, and reported that client/visitor relationships are crucial factors for successful home visiting.

There is ongoing debate regarding what comprises the "best" experience and education for home visitors working with maternal-child populations. Some research strongly supports nurses as the most appropriate and effective home visitors, citing nurses' knowledge of health and community resources as well as their "relationship building and therapeutic use of self" as determinants (Kearney, York, & Deatrick, 2000; Kitzman et al., 2000; D. Olds et al., 2002). Other research adamantly promotes para-professionals or community workers as the most appropriate visitors, attributing their community entrenchment as making them more acceptable to clients thus promoting their ability to work with program participants (Barnes-Boyd, Fordham Norr, & Nacion, 2001).

Barnes-Boyd and colleagues developed a program utilizing a nurse-managed team that included community workers who conducted home visits. Their rational was that the all-nurse model was both costly and often unnecessary (Barnes-Boyd, Fordham Norr, & Nacion, 2001). Doggett, Burrett and Osborn (2005) reported the results from six programs providing services during and after pregnancy to women with drug or alcohol problems. Three of the studies used nurse home visitors, two used trained lay workers, and one used

trained specialists with previous experience in drug treatment services. There were no significant differences based on the education or experience of the home visitor (Doggett, Burrett, & Osborn, 2005). In a Cochrane Library review of programs offering pregnancy support, Hodnett and Frederick reported that a planned subgroup analysis of outcomes based on visitor types was not conducted, in part because the number of programs using visitors other than nurses was very small (only three out of eighteen studies used visitors who were not nurses). Further, initial analysis revealed that the results of the trials using non-nurses were very consistent with the findings of the remaining fifteen trials that used nurses to provide social support (Hodnett & Fredericks, 2007).

Olds is a strong proponent of nurses as home visitors, purporting that not only do nurses have "legitimate agendas" and skills to address the concerns of pregnant women and parents of young children, but that their recognition as honest and ethnical professionals by the US public (Jones, 2005) contributes to their acceptance by and persuasive power with vulnerable families (D. Olds, Sadler, & Kitzman, 2007). The body of work by Olds and Kitzman and 20 studies conducted between 1982 and 1998 and synthesized by Kearney, York and Deatrick (Kearney, York, & Deatrick, 2000)support Olds' belief that home visiting services provided by nurses are superior to services provided by non nurses.

Korfmacher and associates' comparative study examined the differences between nurses and paraprofessionals in implementation of a home visiting program. Nurses completed more visits and spent more time on physical health issues during pregnancy and more time on parenting issues during infancy than paraprofessionals. Visits by paraprofessionals were longer, and focused on safety and environmental health issues more

than visits by nurses. The investigators concluded that nurses and paraprofessionals approached the implementation of a defined set of program protocols differently, but that more research was needed to address if one of the approaches was indeed better than the other (Korfmacher, O'Brien, Hiatt, & Olds, 1999).

In their meta-analysis of home visiting programs for young children, Sweet and Appelbaum (2004) examined the influence of staff type on effect sizes across outcomes. For child cognitive outcomes, visits by professional home visitors were associated with higher effect sizes than visits by paraprofessional visitors; the opposite was true for child abuse prevention outcomes, with paraprofessionals being associated with higher effect sizes than professionals. The authors downplayed the importance of these findings, noting that statistical significance does not necessarily indicate practical significance, with effect sizes for standardized intelligences scales, for example, reaching significance for only a few points difference. They concluded that the educational background of visitors was less important that the individual visitor's ability to work with and relate to the client they serve (Sweet & Appelbaum, 2004).

Visit process and content

The content of home visiting and process for delivering that content is as variable as home visiting programs themselves. As mentioned earlier, the goals and target populations of home visiting programs vary greatly. Sweet and Appelbaum (2004) stated that home visiting for maternal-child populations "operate under the belief that parents mediate changes for their children" and that home visiting programs "share a focus on prevention;" this assertion echoes previous statements that emphasized the importance of children's early years and the role parents play in shaping children's lives (Gomby,

Culross, & Behrman, 1999). One of the perceived benefits of home visiting is the recognition that pregnant women, infants and children are important enough to justify carrying services to them in their own homes and lives, rather than expecting them to search out and seek assistance in settings that are unfamiliar and potentially intimidating.

Byrd (1995) conducted field research in order to expand and refine a model of single home visiting, referring to the processes occurring during a single home visit as opposed to the processes of a home visiting program. The basis of Byrd's work was the Hybrid Model of Concept Development, attributed to Schwartz-Barcott & Kim. Their model described seven phases of the home visiting process: identifying medium, contacting, going to see, entering, seeing, terminating, and telling. Byrd expanded and defined the model to include eight phases of a home visit: surveying and designing, selling and scheduling, approaching the home, entering the home, gaining permission, making the care giving judgment, ending the visit, and haunting and telling. Byrd expounded on each of the step of the model. For example, she envisioned the first phase as requiring more than the home visitor becoming aware of the need for a home visit through referral or other passive means, instead, she believed that the visitor surveyed the available data, pursued more information as needed, anticipated needs, and processed this information prior to contacting the client. Byrd relabeled the model phases to more accurately reflect the intent of each step, and in the case of the "entering" phase, broke it down into two separate pieces she considered unique and necessary – the first was to actually enter the home, and the second was to obtain the permission of the client to interact, preparing the client for the next phase that involved sharing and exchange (M. Byrd, 1995).

Korfmacher and associates' study, although intended to examine differences between nursing and paraprofessionals' approaches to home visiting, provided insight that relates to Byrd's work. Korfmacher and colleagues noted that nurses' knowledge of health issues enabled them to independently assess situations and conditions whereas paraprofessionals, whose training on identification of health concerns was limited, relied on external consultation with the mother's primary care provider. This may explain some of the differences the researchers detected between the focus of nursing vs. paraprofessional visits, including the apportionment of time to various topics and activities. Nurses spent significantly more time on personal health and parenting, while paraprofessionals spent significantly more time on environmental and safety issues and social support (Korfmacher, O'Brien, Hiatt, & Olds, 1999). Byrd's efforts to describe the process of a home visit contribute to the literature by defining the structure of a home visit. According to Sweet and Applebaum (2004), describing what happens during a home visit is "difficult to quantify; there are many intangible factors, such as the personality and attitude of the home visitor, that may influence success but often go unmentioned and unmeasured."

Home visiting depends upon social interaction and the existence of a relationship between the visitor and the client; the formation of a relationship with a client is central to the process of a home visit (Heaman, Chalmers, Woodgate, & Brown, 2007; Pastor, 2006). Jack and colleagues observed that maternal engagement is an important component of home visiting, and that mothers engage with public health nurses and family visitors in a way that limits family vulnerability. Home visiting engagement proceeds through three phases; (1) overcoming fear, (2) building trust, and (3) seeking

mutuality. Personal characteristics, values, experiences, and actions of the visitor and the family influence if and how phases are negotiated and contribute to the development of a working relationship (Jack, DiCenso, & Lohfeld, 2005).

Qualitative research has been conducted to help describe the actual process of home visiting by public health nurses. Zerwekh described three basic competencies of public health nurses conducting home visits: locating the family, building trust, and building strength (Zerwekh, 1992). Twohy and Reif (1997) analyzed transcribed texts from public health nurse visits and coded interventions and activities based on the Nursing Interventions Classification taxonomy (McCloskey & Bulecheck, 1992). This taxonomy was identified by the authors as the most thorough listing of interventions available in the literature at the time. The analysis revealed that 23 interventions and 119 activities were performed by the public health nurses during 14 home visits with high risk prenatal clients. Seven interventions accounted for almost 83% of the public health nurses' time: active listening, childbirth preparation, family integrity promotion, parent education, prenatal care, self esteem enhancement, and support system enhancement. A range of 2 to 23 interventions and 7 to 38 activities were implemented during a single home visit (Twohy & Reif, 1997).

Providing information to clients is a major function of many home visiting programs. Reutter and Ford (1997) determined that nurses enhance client competence by sharing their nursing knowledge and by incorporating and building upon the client's experiential knowledge. McNaughton concluded in her review of fourteen home visiting research studies that home visiting is indeed a context for providing services. She

identified 19 different interventions, including many of the same services identified by Twohy and Reif in their qualitative study (D. McNaughton, 2004).

The importance of establishing and maintaining a relationship with a client and/or family is a thread throughout much of the literature. Peplaus' theory of interpersonal relations was examined by McNaughton and described as a sound conceptual framework for nurse home visiting. As with previous research, McNaughton observed home visitors performing many roles and activities, including providing health information and referrals, giving advice and support and acting as family advocates (D. B. McNaughton, 2005).

Program duration and visits

Sustained relationships between visitors and families are identified by many researchers as necessary for positive outcomes. However, the timing, number, and length of visits vary widely from program to program. McNaughton's review of 13 intervention programs provided one of the most complete summarizations of the number and length of home visits in the available literature. The number of visits ranged from 1 to 71, with a mean of 14.6 and a median of 6 visits. Frequency ranged from weekly to every two months, with an average of one every four weeks. Some researchers postulate that more visits would improve study outcomes; Baldwin and Chen (1996) expressed their opinion that more visits (beyond the 3 to 4 in their study) may have contributed to more adequate prenatal care and a decrease in the number of subsequent births.

Most of the studies reviewed, described models intended to evenly space visits, with some allowing nurses and clients to determine the appropriate number and spacing of visits (Booth, Mitchell, Barnard, & Spieker, 1989), and others decreasing the number of

visits with increasing age of the child (D. Olds, Henderson, Tatelbaum, & Chamberlin, 1986). Rationale for the number of visits was provided by only six of the researchers, with reasons including a need to visit frequently in order to not lose contact with clients (Norbeck, DeJoseph, & Smith, 1996), to deal with the multiplicity of risk factors experienced by the clients, and to have visits coincide with the number of specific content points included in the program curriculum (Cappleman, Thompson, DeRemer-Sullivan, King, & Sturm, 1982). One research group reported their rationale for the number of visits provided was based upon the recommendation of an earlier review that reported a "striking" difference in the positive effects for programs with eleven or greater visits compared to the effects observed in programs with ten or fewer home visitor/client contacts (Heinicke, Beckwith, & Thompson, 1988). McNaughton's review found that only three of thirteen studies reported the length of the home visits. The amount of time documented in the three studies ranged from 10 to 36 hours (D. McNaughton, 2004).

Sweet and Appelbaum's (2004) meta-analysis examined the intended length of programs targeting families with young children – almost 50% of programs were intended to last between nine and twenty four months. Nearly 25% of the programs they examined initiated care in the prenatal period. Four or five programs were intended to last three or fewer months, and the same number were intended to last three to five years – several programs had no end date identified at all. Average number of home visits and average total number of contact hours were reported inconsistently and by programs with smaller sample sizes, resulting in limited ability to analyze the findings. The researchers did note that the child cognition outcomes were the only ones that were significantly related to

number or duration of visits, but that the number of home visits and length of time spent was positively associated with effect sizes observed (Sweet & Appelbaum, 2004).

Theoretical Perspectives

Home visiting uses a variety of theoretical frameworks, typically linked to the purpose or goals of the program or study. Parent education, family support and infant mental health are broad areas of interest to home visiting programs (Behrman, 1999). Programs focused on parenting education are often structured around theoretical constructs of self efficacy and social competence, assuming that parents can make better health and life management choices if they are confident in their own decision making skills and are well informed about not only the availability of services but also how to effectively use services (Grace, 1989). Programs focused on family support often use the human ecology or human attachment model, as those models focus on the interrelations of individuals, families, and communities, and the impact of interactions on health and social decisions (Bubolz & Sontag, 1993). Programs targeting infant mental health may be based on theories emphasizing the importance of maternal engagement and parent-infant bonding (M. Graham, White, Clarke, & Adams, 2001; Halpern, 1993).

McNaughton performed a systematic review of home visiting research on pregnant women and young children conducted between 1980 and 2000, and voiced a concern about the lack of clear theoretical linkages between client problems, nursing interventions and targeted outcomes (D. McNaughton, 2004). Most of the studies in the review did not use a specific theoretical framework, instead focusing on concepts of interest, including social support e.g.(Bryce, Stanley, & Garner, 1991; Norbeck, DeJoseph, & Smith, 1996), interpersonal competence e.g.(Booth, Mitchell, Barnard, & Spieker, 1989), vulnerability

and maternal competence e.g.(Koniak-Griffin, Anderson, Verzemnieks, & Brecht, 2000), parenting e.g.(Armstrong, Fraser, Dadds, & Morris, 1999) and maternal health habits and association with low birth weight birth e.g.(D. Olds, Henderson, Tatelbaum, & Chamberlin, 1986). Although studies rarely explicitly referred to theoretical frameworks, those few that did used the interaction model of client health behavior (Barnes-Boyd, et.al., 1995), the ecological model(Black et.al., 1994), Orem's self care model (Chen, 1993), and the model of maternal-infant bonding (Hall, 1980). One of the studies wove together concepts from three frameworks (human ecology, self efficacy and human attachment) to create a coordinated approach for the study (Kitzman et al., 1997). McNaughton's review identified many of the frameworks and concepts commonly applied in maternal-child home visiting. She examined and proposed Peplau's theory of interpersonal relations as a framework for home visiting (D. B. McNaughton, 2005). Bowen's family systems' theory has also been used to guide home visiting programs and research (P. Goodwin, Garrett, & Galal, 2005).

A thorough analysis of each of the theoretical frameworks used in home visiting is beyond the scope of this research. Depending upon the goal and purpose, plausible arguments may be made for each of the theories. Each of the theories present relationships between family members and the larger community and society in which they exist. Individual's perceptions of themselves and their role in the family and community may be influenced and improved by relationships with helping partners, including other family members, friends, and home visitors.

Human ecology theory presents human relationships with their environment as an interactive system (Bronfenbrenner, 1979). Biological, social, and physical aspects of

system may be the natural world or realities constructed by humans, and/or the social and cultural milieu in which the organism exists. Human ecology theory is based on a series of assumptions, including that families and the environment are interdependent, families are part of the total life system and families continuously adapt to multiple environments in which they exist (Bubolz & Sontag, 1993). Olds and Kitzman are strong proponents of the ecological model to guide home visiting practice. Kitzman's work wove concepts from human attachment and self efficacy theories around the human ecology theory, viewing the role of home visitors as not only helping families make use of health and human services, but also to support involvement of family and friends in the pregnancy, birth, and early care of the child, by establishing trusting relationships and helping women set and reach small, achievable goals that increase their confidence to manage greater challenges(Kitzman et al., 2000).

Kearney's review partially supported social ecology theory as an appropriate basis for home visiting by nurses to maternal-child populations. Maternal outcomes and parenting that were examined as interim variables improved in approximately half of the studies reviewed. Child development outcomes were improved in less than one third of the studies, stimulating the proposal of parent-infant interaction theory as another appropriate model for home visiting programs (Kearney, York, & Deatrick, 2000).

Olds and Kitzman summarized what they considered crucial factors that assure home visiting programs will improve health outcomes: (1) based on ecological models, (2) designed so nurse home visitors work with families during pregnancy and during early childhood, establishing therapeutic and long term relationships, and (3) targeted to serve

families at risk for health problems due to poverty and lack of personal and social resources (D. Olds, Hill, Robinson, Song, & Little, 2000).

Funding and Cost Analysis

Home visiting program are funded differently based on the target population and goals of the program. State administered programs often use a combination of federal, state, and local funding available through public and private sources. Federal sources include Medicaid, State Title V Maternal and Child Health Services Block Grant (Title V), Healthy Start, and Temporary Assistance for Needy Families (TANF) (ASTHO, 2006; Gallagher, Botsko, & Schwalberg, 2004). Tobacco settlement funds, administered through states, are also being used to support home visiting programs (Romero, Chavkin, Wise, Hess, & VanLandeghem, 2001), as are state general funds, which continue to be a major support of state-based home visiting (ASTHO, 2006; Johnson, 2001). Home visiting aimed primarily at child abuse prevention is funded at least in part by Children's Trust Fund in several states, including Alabama, Massachusetts, and Missouri.

Like the funding source, the reported cost of programs varies widely. An analysis of early intervention programs conducted by the Washington State Institute for Public Policy reported the costs for home visiting services, including the average cost per child for Old's Nurse Family Partnership (NFP) Program. The average cost per child for the NFP program was $7,886 per child; other programs ranged from a cost of $1,681 to over $49,000 per child. The ability of programs to economically provide services to families is of interest to policy makers. A widely distributed analysis of early intervention programs (including home visiting) was conducted by the Washington State Institute for Public Policy. Cost benefit was based on monetary values from observed changes in the

incidences of subsequent births, use of public assistance, involvement in the criminal justice or child protection systems, and substance use was calculated for home-visited families compared to non-home visited families. The researchers concluded that some home visiting programs demonstrated cost effectiveness, returning between $6,000 and $17,200 per outlay per youth, while others reported no discernable changes in outcomes, resulting in net losses of between $37,400 and $49,000 per youth (Aos, Lieb, Mayfield, Miller, & Pennucci, 2004).

Evaluation

A well designed evaluation can help direct and guide a program, enhancing its capacity and effectiveness. Ideally, evaluation is an integral part of a program, with goals and outcomes clearly established, appropriate data identified and gathered from the outset, and routine analysis of findings used to modify and improve program activities. In reality, evaluation of individual public health programs has been more of an afterthought than a program component, with the cost of evaluation "competing" with implementation dollars. Demands to respond to perceived need may also press policy makers to expand or replicate a program without carefully examining if the program is working well or efficiently (Chapman, Siegel, & Cross, 1990).

Home visiting, with its myriad target groups, variety of goals, and variability of providers and program content, frequently suffers from a lack of organized evaluation, complicated by individuation of services from client to client and challenging evaluation by varying how and what services are provided, even within a single program. Home visiting programs often arose from services or prevention efforts without the benefit of a research design or evaluation component. Three basic questions that evaluations of

human service programs should be designed to address include: (1) what services did the program provide, (2) who received the services and (3) did the services produce the anticipated outcomes. Answering the first two may be satisfactory if the evaluation is intended to only help modify or tweak an existing program, and program outcomes may only be evaluated as the need to expand or replicate programs come into play (Gomby, Culross, & Behrman, 1999).

The designs of research studies include evaluating the degree to which program interventions help meet program goals. Ideally, research studies are more controlled than service delivery programs, with better program fidelity and outcome analysis. Olds et.al. (2007) questioned whether research programs can be reliably replicated, and if those programs can and will produce similar results in community settings. They cautioned that "simply knowing that a program can work in a research setting does not mean that it can be effectively translated into community practice" (D. Olds, Sadler, & Kitzman, 2007).

Summary of Home Visiting Services

Maternal-child home visiting programs differ in their target populations, goals and purposes, lengths of service and program designs. A single unifying feature of home visiting is that clients are provided the program services in their own environment by a visitor with whom a relationship exists. The quality of the relationship is important to successful home visiting, and research and practice has demonstrated that nurses have the knowledge and capacity to provide home visiting services.

Birth outcomes, specifically prematurity and low birth weight, are affected by demographics, maternal physiologic and psychological factors, maternal behavior and the environment. Some factors, such as demographics are not amenable to change others may

be moderated through appropriate intervention. Medical prenatal care, nutritional programs, and economic support programs are important mechanisms that can mitigate certain risks. Home visiting, providing a variety of services based on the needs of each mother and family, can improve pregnancy outcomes and support families to be more confident and prepared to raise their young children.

The charge to state governments, in the form of the Maternal and Child Health (MCH) Block Grant is to "improve the health of all mothers and children" and to provide services necessary to develop and expand "maternal and infant health home visiting programs." This charge places a burden upon state MCH agencies to not only implement home visiting services but to evaluate the effectiveness of home visiting and to assure the availability of effective services as resources allow.

Home visiting in Montana

Frontier nurses provided home visits to women in mining and agricultural communities as emigrants came to Montana in the late 1800s and early 1900s. Early accounts include those of nurses and physicians providing services that included prenatal care and midwifery, infant care, communicable disease treatment and management, and counseling and support, recognizing that many families left behind their support systems when they traveled to the frontier. Dr. Mollie Babcock included information and education about contraception, recognizing that unwanted pregnancies were a common concern, with attempted abortions contributing to the morbidity and mortality of childbearing aged women (Grana, 2005). Public health nurses' daily reports, submitted to the state department of health, included accounts of group education in general stores in

small communities and home visits to check on pregnant women and teach women about infant care (Stremlau, 1932).

No standardized program for home visiting existed in Montana until the 1980s. Prior to that time, home visits were provided on a case by case basis from community to community, based on the availability of visitor time and resources. In 1986, local public health departments in four communities received funding from the (then) State Department of Health and Environmental Sciences to hire a part time public health nurse to identify women who needed help finding and paying for prenatal services, and to visit these women and assist them to access and attend prenatal care. These pilot projects were predicated on the assumption that early entry into prenatal care early would result in improved pregnancy outcomes, consistent with the national trends leading to the Institute of Medicine "Futures" report. Public health nurses in the four communities contacted local primary care providers and developed agreements with them to accept pregnant women without resources as patients, usually on a rotating basis and sometimes with the guarantee of payment for medical care costs as contract and community resources allowed. The public health nurses reached out to services and programs where pregnant women may seek help, including offices of public assistance (AKA welfare offices), WIC, emergency rooms, and posted notices about the availability of services in grocery stores, Laundromats and child care settings. The nurses contacted women in the women's homes, and the service, initially intended to be a single home visit to assess needs, instead became a variety of services provided through a series of visits. One impetus for repeated home visits were calls from primary care providers who had accepted the women as prenatal clients, requesting help from the public health nurses finding clients who missed

visits or to request that the public health nurse assist the client to locate housing, insurance, or other community services. Clients also contacted the nurses for assistance in identifying and/or accessing other services in the community (Pettit, 2007).

Based primarily on anecdotal reports from clients and providers regarding their satisfaction with the services, and despite the lack of evaluation regarding effects on pregnancy outcomes, legislation was introduced to formalize and expand the program in 1989 (Espelin, 1990). Montana's Initiative for the Abatement of Mortality in Infants (MIAMI) was introduced to the legislature by Representative Wyatt, who stated that the bill would "ensure that mothers and children, particularity those with low income or limited availabilities for health services receive access to quality to maternal and child health care services" (*Hearing on House Bill 773*, 1989). The bill was presented as a mechanism to improve pregnancy outcomes and decrease infant mortality, and as a potential cost savings measure. Proponents claimed that the high cost of neonatal intensive care could potentially be resolved, in part, through the provision of comprehensive, coordinated services to high risk pregnant women (Gallagher, Botsko, & Schwalberg, 2004; , 1989).

MIAMI was approved by the Montana legislature in 1989. The stated purpose of the MIAMI project was to (1) ensure that mothers and children receive access to quality maternal health services, (2) reduce infant mortality and the number of low birth weight babies (5½ pounds or less), and (3) prevent the incidence of children born with chronic illnesses, birth defects, or severe disabilities as a result of inadequate prenatal care (Johnson, 2001). The law charged the Department of Health with providing the following services: (1) infant mortality review, (2) assistance to low-income women and infants to

access to prenatal care, delivery, and postpartum care, (3) referral of low-income women and children to other programs to protect the health of women and children (including WIC, Family Planning and other “maternal and child health programs”), and (4) public education regarding the importance of early prenatal care, good health habits during pregnancy and availability of services for pregnant women and children ("The Montana Initiative for the Abatement of Mortality in Infants", 1989)

Easy access to prenatal care, education, and risk assessment during pregnancy and care coordination (including case management) were perceived by policy makers and DHES program staff as important mechanisms to improve birth outcomes (Gallagher, Botsko, & Schwalberg, 2004). One Medicaid change intended to facilitate access to prenatal services was presumptive eligibility for pregnant women, which was incorporated into the Montana Medicaid State Plan and Administrative Rules of Montana (ARM) in 1990 (DPHHS, 1990). A second Medicaid policy strategy also intended to improve access and care coordination was targeted case management for high risk pregnant women, which was incorporated into the Montana Medicaid state plan and ARM in 1991 (DPHHS, 2001a). Under the provisions of these laws, pregnant women could be determined eligible and receive continuous prenatal services based on an abbreviated Medicaid eligibility assessment, and case management services could be provided by a qualified provider to high risk pregnant women through 60 to 90 days after the end of the pregnancy. Home visiting was identified as the preferred method of service delivery for targeted case management of high risk pregnant women.. Throughout the 1990s and 2000s, local communities received contract funds from the state to provide home visiting services to high risk pregnant women and their infants. Originally known

as “MIAMI” programs, the program was renamed “Public Health Home Visiting” in contract language in the early 2000s in order to more clearly describe the program purpose. The program grew from four programs serving 200 women in 1987, to 26 contractors providing services to 1,555 pregnant women in 2002.

Target populations.

Montana’s home visiting program originally targeted and continues to focus on “high risk” pregnant women and their infants. The original MIAMI program model identified risk factors as “moderating factors,” identifying conditions that were perceived as potentially negatively affecting pregnancy outcomes, including demographics, pre-pregnancy health status, obstetric history, and socioeconomic factors (Espelin, 1990). Early program planning was based on work by Olds; however, unlike the Olds model, the program was open to all at risk women, regardless of maternal age or parity. Montana’s sparse population and limited public health resources were factors in the decision to create a home visiting program that could serve all high risk pregnant women (Espelin, 1990).

Case management criteria, first established in Administrative Rule of Montana (ARM) 1991 and updated in 1997, were aligned with the original MIAMI model moderating variables, and described a pregnancy as high risk if the woman:

a. was age 17 years or younger;
b. had medical factors that indicate the potential for a poor pregnancy outcome;
c. used alcohol or illicit drugs or had someone in their immediate environment who used alcohol or drugs;

d. was in an abusive relationship; or

e. was homeless.

If a woman did not qualify for services under these criteria, she could also be qualified if she demonstrated an "inability to obtain necessary resources and services" and met at least three of the following criteria:

a. had a history of physical or sexual abuse;

b. had no support system or involvement of a spouse or other supporting person;

c. had one or more children under age five;

d. was not educated beyond the 12th grade level;

e. had a physical disability or mental impairment;

f. had no prenatal care before or during the first 20 weeks of gestation;

g. was a refugee;

h. was age 18 or 19 years; or

i. had limited English proficiency (DPHHS, 2001a).

Medical risk factors were outlined in MIAMI Home Visiting manuals, and included history of preterm labor or delivery, history of chronic health conditions such as hypertension or diabetes, and/or pregnancy induced conditions including pre-ecclampsia or gestational diabetes. Criteria were purposely left broad to allow broad inclusion in the program based on the discretion of the program staff.

The number of programs grew to include contracts with 23 county health departments and six tribal health departments providing MIAMI project services in 33 counties and on six reservations in state fiscal year 2002-2003 (Gallagher, Botsko, &

Schwalberg, 2004). Demographics of clients varied from project to project, with some programs serving only very young mothers, others serving high (or low) ratios of American Indians to white populations, and some serving almost exclusively Medicaid clients. In 2003, due in part to legislative scrutiny, an assessment of the data received from contractors revealed much variation in the delivery of home visiting services, the frequency of visits, and the per client costs. In order to standardize services and funding distribution, a call for proposals from interested communities was issued in 2003 (Henderson, 2003). The call established the home visiting team structure, the minimum standards for the number of women and infants to be served, the number of visits required during the prenatal and infant periods, and required the communities to describe the method of case finding and community outreach they would use. Sixteen proposals were received from communities, and fourteen contracts were established in 2004. Additional outreach and procurement resulted in additional sites and in 2006, there were 16 contracted agencies providing home visiting services in Montana, including 15 county health departments and one tribal health department.

Purpose and Goals

The basic goals of MIAMI are to improve pregnancy outcomes and decrease infant mortality. The rate of low birth weight births has been an outcome measure for the program since its inception.

Visitors

Home visiting services in Montana were initially provided by public health nurses. When rules for targeted case management for high risk pregnant women were developed in Montana in 1990, home visiting services were designed to be delivered by a team of health

professionals, including a public health nurse, a social worker and a dietician. This model was adapted from Washington State's First Step program. Targeted case management rules require that one of the team members must be employed by the contracting agency; the other two may be contracted positions.

In the 1990's, some local contractors opted to add a para-professional to the home visiting team. Para-professionals were not reimbursable for targeted case management services under the Medicaid program; these paraprofessionals were intended to allow programs to increase the number of home visits to certain client populations, specifically those at risk for Fetal Alcohol Spectrum Disorder (FASD). Six of the PHHV sites receive additional grant funding from SAMHSA to target woman at risk for having a child with Fetal Alcohol Spectrum Disorder. Women are identified through an enhanced assessment process.

Visit process and content

Home visiting programs in Montana were not required to provide a certain number of visits to clients; training in the 1990s recommended six to nine prenatal visits (Henderson, 2007). The average number of visits in state fiscal year 1995 was 7, dropping to 5.34 in 2002 . The number of visits varied from site to site and client to client; the minimum number of visits reported in both 1995 and 2002 was one, and the maximum number 62 and 78, respectively. Early program visit content included information on the signs and symptoms of premature labor, smoking cessation, nutritional education, breastfeeding promotion and education, and information on toll free help lines and other community services (FCHB, 1995, , 2002b). Some contractors developed standardized nursing care plans based on various guidelines and frameworks,

including Missoula County, which developed and used Standardized Care Plans based on the Health Resources and Services' Administration's Region X guidelines. Program training also sought to improve maternal-child attachment, implementing a training program for nurse home visitors using the Nursing Child Assessment Satellite Training (NCAST) tools. NCAST is a series of tools initially developed by Katherine Barnard at the University of Washington, and used by community health nurses to assess parent-child interaction and to guide interventions (Farel, Freeman, Keenan, & Huber, 1991).

Theoretical Perspectives

Montana's home visiting project developed without an a priori theoretical basis. The community-based programming, its focus on referral and linkages to medical and social services, as well as the efforts to continue services beyond birth suggest that a family system or ecological framework may have guided early program development.

Funding and Cost Analysis

The home visiting program in Montana has been funded in a variety of ways over the years. In 1993, the home visiting programs in 17 communities reported total costs of $625,336, with the largest funding source (43%) being local funds. The state general fund provided 26% of the funding, Maternal Child Health Block Grant (MCHBG) 14%, and Medicaid Targeted Case Management (TCM) provided 17% of the total costs. Program costs were estimated to range from $330 to $450 per client (Program, 1995). In the mid 1990's, increased MCHBG funds to Montana allowed home visiting to expand to serve families with children up to age three years, but the increase was short lived, and in 2000, the MCHBG was removed from the home visiting contracts, and the target population again focused on prenatal to the first birthday. Since 2000, PHHV program contracts have

been funded by state general fund. At the local level, contractors support the program with local public health dollars (mill levies), billing revenue from Medicaid targeted case management, and in some communities, with MCHBG funds distributed to all counties for maternal-child health services. In 2002, $473,943 in general funds and $80,940 TCM funds for a total of $554,883 supported home visiting programs in Montana. Calculated costs per client based on these two funding sources were $357.

In 2003, due to deficits in the state budget, the home visiting program funding was slated for removal from the state budget. Local health department staff, clients, health providers, and maternal-child advocates defended the program to legislators, and the funding was restored to the budget. The budget restoration brought with it interest in and scrutiny of the services being provided yet, even with limited evaluation, the program continues to be popular; in 2007, the legislature earmarked additional funding, bringing the total general fund available to support home visiting in Montana to $700,000 (*Public Health and Safety Division - Program Legislative Budget*, 2007).

Evaluation

Evaluation in the 1980s and early 1990s was limited to anecdotal reports from local programs. In 1992-93, an “Intake and Outtake” form was developed, and forms reporting demographic and outcome information on pregnant women served were submitted to the state agency. Evaluation of programs has been primarily descriptive, focusing on numbers served and documentation of risk factors and the birth weights of babies born to home visited clients; no formal comparison between project sites and/or the birth cohort in general was conducted. A cursory examination of program data from 2002 revealed that home visiting programs served a high proportion of American Indian

women; 21.9% of the clients served were American Indian, although only 12.6% of births were to American Indians that same year (DPHHS, 2003; FCHB, 2002a). Program data also revealed that 47.4% of women reported smoking, 12.2% using substances, and 22.9% using alcohol at intake. The reported low birth weight rate for the home visited population according to the program data was 7.8%, compared to 6.8% for all births in Montana in 2002. Presentation of the above data during legislative session validated that the programs were indeed serving high risk women, and while the low birth weight rate was higher than the general population, the higher rate apparently was accepted as evidence of success considering what seemed to be existing risk factors.

Montana Home Visiting Summary

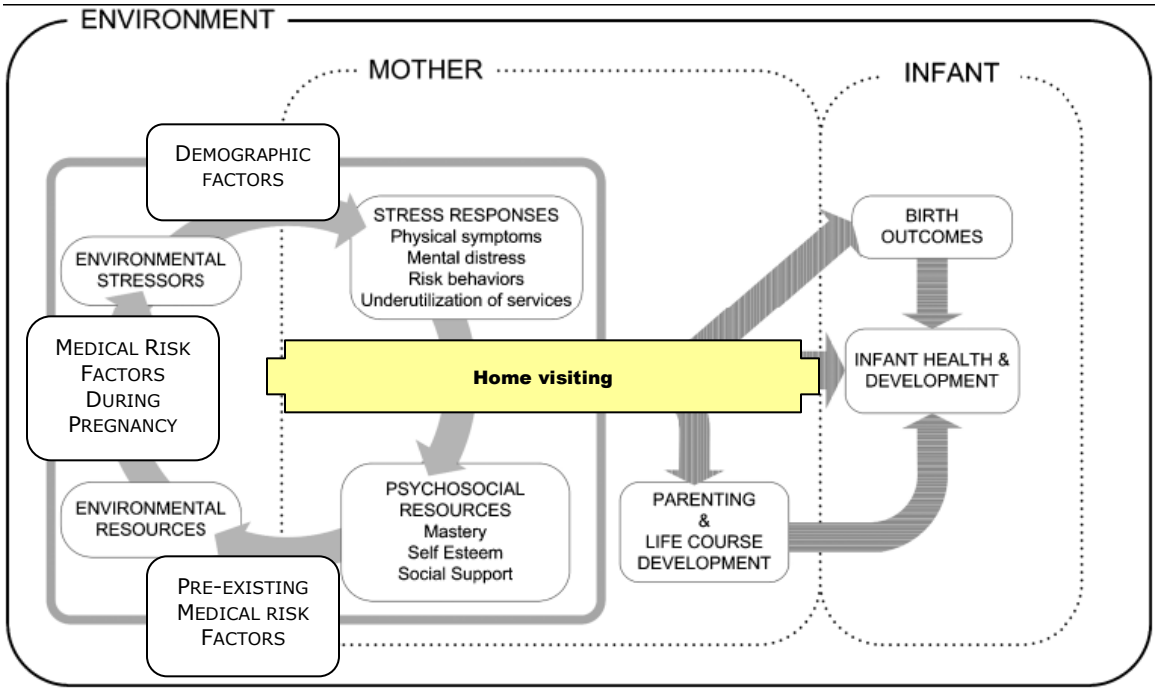
Montana's home visiting program, as with many other public health home visiting programs, has changed over the last two decades, in response to charges, needs and available resources. Despite the long history and ongoing interest in the program, there is a lack of basic research regarding the effectiveness of home visiting on a large scale in a rural state. Montana's home visiting program targets many modifiable risk factors, including stress, nutritional adequacy and tobacco use during pregnancy. However, available data is seriously flawed; missing data plagues accurate assessment. For example, the birth weight rate of home visiting in Montana was based on only 788 births or 51% of the 1555 intakes and outcomes received. Data also did not extend beyond the birth outcome, so a report of the impact of the program on infant mortality is impossible. Comparison of the home visited population to the general population is also likely problematic, as the project only targets high risk women. A comparison of outcomes between women with similar demographics and assumedly similar risks would more

accurately reflect the impact of the program on birth outcomes. The degree to which services actually improved pregnancy outcomes has not been adequately evaluated, due in large part to the lack of experimental design that could provide meaningful comparison group data. As previously noted, questions about program outcomes may not be addressed until there is a need to persuade funders to continue, expand, or replicate the services (Gomby, 1999). If Montana intends to continue and potentially expand home visiting services, program staff must first be able to accurately and realistically assess whether or not the program addresses the stated goals of the program. Evaluation must also be based on data that are high quality and with defined levels of validity and reliability that may lead planning for program improvements based on sound analysis and findings.

Conceptual Framework

For the purposes of this research, an ecological framework was applied. Birth outcomes are impacted by demographic factors, pre-existing medical factors, and medical risks that arise during the pregnancy. Birth outcomes are also affected by maternal health behaviors, the environment in which the mother lives, and by stressors affecting the ability of the woman to adapt to and adjust. Roman and colleagues presented a conceptual framework depicting how environmental stressors and psychosocial resources affect birth outcomes, parenting and life course development, and ultimately, infant health and development (Roman et al., 2007). A modification of their conceptual framework, with inclusion of demographic and medical risk factors and overlaid with home visiting as a continuum of services, is pictured in Figure 4.

Figure 4 Ecological Home Visiting Conceptual Framework



Home visiting can impact outcomes by providing support, intervention and advocacy throughout the course of the pregnancy and into the perinatal period, improving the capacity of the woman to decrease risk behaviors and manage her environment in a way that can improve birth outcomes. Research has demonstrated that certain risk behaviors, such as tobacco use, nutritional adequacy and stress management can be positively influenced by home visiting. The current research was predicated on the assumption that home visiting services in Montana have the capacity to modify outcomes by enhancing maternal functioning.

Significance of the Research

Home visiting has been and continues to be a method used to provide a wide variety of services to the maternal-child population. However, evaluation of the home visiting services continues to provide variable outcomes, leaving practitioners and policy makers to question if funding home visiting programs is a wise use of resources. Public

health providers and policy makers have a responsibility to assure that services are effective and efficient. Nurses carry the burden of public health service delivery in rural and frontier settings, and can most confidently deliver these services if they are armed with accurate and sound assessment of the services provided and outcomes achieved.

Specific Aims

The specific aims of this study were to:

Aim 1: Determine the predictive ability of six demographic measures to identify low birth weight and premature births in Montana.

> Hypothesis: Women who are less than twenty years of age or greater than thirty four years of age, are non-Caucasian, have less than or equal to a high school education, are unmarried, who live in rural or frontier communities, or who have a public payer source (Medicaid) are more likely to experience poor birth outcomes, specifically low birth weight and/or premature births.

Aim 2: Examine the impact of home visiting, medical prenatal care, and select physiologic and behavioral risk factors on the incidence of low birth weight and/or premature birth in high risk women Montana.

> Hypothesis: High risk women receiving home visiting services and adequate prenatal care will have lower incidences of low birth weight and premature compared to high risk women who did not receive home visiting services and/or adequate prenatal care in Montana.

Aim 3: After controlling for adequacy of prenatal care, compare average Medicaid billed charges for infants born to high risk women who did and did not receive home visiting services during their pregnancy.

Hypothesis: The Medicaid billed charges during the first year of life for infants whose mothers received home visiting services during pregnancy will be lower than the Medicaid billed charges for infants whose mothers did not receive home visiting services.

CHAPTER III

Research Design and Methods

Overview and Rationale

The purpose of the study was to evaluate the effectiveness of demographic measures to predict the occurrence of low birth weight and premature births in Montana in 2006 (Aim 1). The associations between the provision of home visiting and receipt of medical prenatal care and the incidences of premature and low birth weight births in Montana were assessed (Aim 2), and the differences of charges incurred for Medicaid services for infants based on whether or not their mother received home visiting services were also examined (Aim 3).

The study was quasi-experimental, using a retrospective case control design. This type of design efficiently uses pre-existing public health data and allows for identification of and comparisons between an intervention (home visited) group and comparable high risk reference group, thereby enhancing sample size and power (Hulley et al., 2001, p. 98). Disadvantages of the design include limitation of the data available for analysis. Specifically, certain risk factors associated with the incidence of premature and low birth weight births, including the presence of infection, domestic abuse and homelessness are not reported on birth certificates. Dose data, such as the amount of tobacco use or the number of home visits, were not able to be examined in the present study; published studies on these factors are available in the literature.

Setting and Sample

High risk women who lived in and delivered a live born singleton infant in the state of Montana in 2006 constituted the target population. The determination of risk is a

complex one, due in part to the multiple factors that contribute to poor birth outcomes, and the fact that no single risk assessment mechanism has been identified that adequately or accurately identifies women at risk for low birth weight and premature birth. In home visiting and other prenatal intervention programs, risk assessment typically uses information that is available early in pregnancy and requires limited invasive or costly collection methods. For example, a Prenatal Public Health Risk assessment system developed and used in New York identified women at risk based on the presence of one or more of the following variables: maternal age less than 21 years, high school education or less, Medicaid enrollment, smoker, and unintended or mistimed pregnancy (Lane et al., 2001). Even these commonly used indicators can be challenging to data collection; the determination of pregnancy intention is variably defined, and Medicaid enrollment excludes women due to homelessness or undocumented residency status.

Several options for identifying the high risk population were considered. One option was to base identification of high risk status on the presence of demographic factors alone. Factors identified included: maternal age < 20 or > 34 years, unmarried, rural residency, non-Caucasian, and less than high school education. This risk assessment approach was analyzed by Goodwin and associates with receiving operating characteristic curve plots, which are graphic displays used to examine sensitivity and specificity (L. Goodwin et al., 2001; Hanley, 1989). They reported on the predictive ability of seven demographic variables for premature birth outcomes in a racially diverse population. The variables included the five listed above as well as payer source and religion, which are not reported on the birth certificate. The seven demographic variables yielded a 0.72 area under the curve level, where 1.0 is indicative of perfect prediction (L.

Goodwin et al., 2001). Advantages to this option would be that all indicated demographic factors are documented in the literature as associated with increased risk of low birth weight and/or premature birth. Demographic indicators are also readily available not only on birth certificates (for the research and reporting purposes), but also in practice through a limited and non-invasive intake assessment. Use of the demographic variables alone simplifies analysis of risk factors such as alcohol and tobacco use, and would result in a large comparison group.

A second option was to use a combination of demographic and medical risk factors to identify risk. This is the approach presently used by the PHHV program in Montana. Comparability of the intervention and non intervention group on these factors would be likely and therefore an advantage. Lane and colleagues used this approach, and assessed the relative risk, sensitivity, and specificity of five variables, including maternal age, education, payer source, tobacco use and pregnancy intention to identify risk of low birth weight birth or infant death. Each of the five risk factors represented at least 10% of the population attributable risk (PAR) for low birth weight or infant death, and together, the risk factors accounted for 75% of the risk, meaning that 409 of the 470 women in their study who had a low birth weight infant would have been correctly identified using only one of the five risk factors (Lane et al., 2001).

A third option was to match the non home visited population with home visited clients, creating matched pair cohorts. Matching would be based on a pre-selected list of criteria such as demographic and medical and behavioral risk factors. This option would provide a well controlled, comparable population, however there is a risk of overmatching the population, and the method is extremely labor intensive, considering

the task of matching all home visited clients served. In order to make this option viable, matching would need to be limited to very few factors, with the likely result that this option would yield no better match that the demographics only option.

For the current study, the second option was adopted, whereby risk assessment was based on demographic variables and selected medical and behavioral factors. Factors selected included those identifiable early in pregnancy and available in the linked data set, primarily birth certificate data. State law requires that birth certificates be filed with the Montana Department of Health and Human Services in Helena, Montana (DHHS, 2003, p. 12; DPHHS, 1995a). Birth certificate and linked death files are available for the purposes of public health surveillance at DPHHS; Montana law permits the release of information on infant morbidity and mortality if the intent of those requesting the release is to "reduce those problems" (MCA, 1995). Compliance with reporting requirements resulted in a comprehensive data set; the National Center for Health Statistics (NCHS) estimated that 99% of all U.S. births were reported in 2002 (DHHS, 2003).

Inclusion Criteria

Birth outcome data for women living in and delivering a singleton infant in Montana were included in the study. Women were determined to be at risk for poor pregnancy outcome based on the documentation of one or more of the demographic, behavioral or medical risk factors significantly associated with both premature and low birth weight birth. Demographic risk factors are reported in sections 1 through 26 on the birth certificate, medical risk factors in section 40a, and behavioral risk factors in section 40b (DPHHS, 2001b).

A PHHV Intake and Outcome (I & O) record indicating at lease one home visit provided evidence that the pregnant woman received home visiting services. I & O Forms were submitted by contractors to the Montana State Department of Public Health and Human Services (DPHHS).

Exclusion Criteria

Birth certificates that did not include data on the dependent or outcome variables (gestational age or birth weight) were not included in the analyses. In 2006, less than 1% of the singleton births in Montana did not have gestational age and/or birth weight reported.

Minority Considerations

Minorities were represented in 2006 singleton births examined in this study. Of the 12075 singleton births in the data set, 84.8% were Caucasians, 12.7% American Indian, 0.5% African American, and 1.7% "other," including Filipino, Chinese, Japanese, and mixed race. In the home visited population, 83.4% were Caucasians, 14.2% American Indian, 0.8% African American and 2.1% "other."

Procedures and Data Collection

All data were obtained from data sources filed with DPHHS for mandatory reporting and program compliance. Data sources included Montana birth certificates, Medicaid claims and PHHV records. Birth certificate data is available to the state as mandated reporting by hospitals or birth attendants.

PHHV program intake and outcome data, available both electronically from the Public Health Data system and by hard copy for verification purposes, were used only to identify clients that received home visiting services. All other risk indicator data and cost

data were obtained from birth certificate and Medicaid data. Medicaid data were drawn from the Montana's Medicaid Information System (MMIS). This system is a mechanized claims processing and information retrieval system, developed by the state using guidelines and standards from the Center for Medicare and Medicaid Services (CMS) (CMS, 2007).

Data linkage was performed by Medicaid program staff, capturing all Medicaid births indicated by diagnosis/DRG codes on a claim for the child, or a Medicaid eligible child matched to a Medicaid eligible mother and the mother has a claim with a delivery diagnosis or DRG code. Files were matched based on maternal name and date of birth, and infant name and date of birth. The data set was provided to the researcher in the form of an Excel file by the Office of Public Office of Planning, Coordination and Analysis (OPCA) staff in December, 2008.

Measurement of Variables

Home visiting services

The independent or intervention variable was receipt of home visiting services by a contracted Public Health Home Visiting agency during the prenatal period. Evidence of service delivery is in the form of an Intake and Outcome Form and, for the purposes of this research, home visiting was defined as any home visit service provided by Public Health Home Visiting/MIAMI providers under contract to provide these services to high-risk pregnant women. Home visiting was examined as a categorical indicator; the available data did not include information on the quality or quantity of home visiting services received. Future research projects will examine if birth outcomes differ based on

the number of home visits, the duration of the visits, and/or the content of the visits as documented in client records.

Effectiveness of Prenatal Care

Given the conflicting findings for the effectiveness of prenatal care described in the literature review, the role of medical prenatal care was considered as a potential moderating variable in birth outcomes. Receipt of adequate prenatal care was determined based on the Adequacy of Prenatal Care Utilization (APNCU) Index, developed by Kotelchuck (M. Kotelchuck, 1994a). The APNCU index identifies the number of prenatal visits received in relation to the timing of initiation of prenatal care. The ACOG Standards of Prenatal Care are used to determine the appropriate timing and number of visits. The APNCU is calculated by as a recode of data from birth certificate item 30 (month of pregnancy prenatal care began) and item 31 (prenatal visits). Inadequate prenatal care is defined as receiving 0 - 49% of expected visits, intermediate is defined as 50 - 79% of visits, adequate as 80 - 109% of expected visits, and adequate plus prenatal care is defined as 110+% of expected visits.(M. Kotelchuck, 1994). The adequate plus category indicates women received more than the expected number of visits, and may point out pregnancies which were complicated by chronic medical conditions or other problems (Hillemeier, Weisman, Chase, & Dyer, 2007). To illustrate the interpretation of the APCNU, the ACOG recommendation for a 40-week gestation pregnancy is 14 visits; if care began in the third month, two visits would be missed, with an expected 12 visits. Therefore, a woman who began prenatal care in the third month of pregnancy and received ten prenatal visits would have received 83.3% of the recommended visits

according to the ACOG standards, meaning the prenatal care would have been rated as adequate (M. Kotelchuck, 1994b).

Low Birth Weight and Prematurity

The dependent or outcome variables of low birth weight and prematurity were developed from recodes of data from the birth certificate. Recodes created dichotomous variables which designated birth weight as low (singleton infants weighing less than 2500 grams at birth) or normal (singleton infants weighing ≥ 2500 grams at birth), and gestational age as premature (singleton infants with a gestational age less than 37 weeks) or normal (singleton infants with a gestational age of ≥ 37 weeks). Although some studies report birth weight and gestational age as continuous measures, the practical application of determining the mean differences in birth weight across populations is limited. Table 2 presents each variable and the associated data source.

Table 2 **Public Health Home Visiting Study Variables**

	Category	Description	Data Source
Independent Variables	Home visiting	Evidence of receipt of home visiting services from contracted Public Health Home Visiting agency	Intake Outcome Form and/or the Public Health Data System (PHDS)
	Adequacy of Prenatal Care Utilization (APNCU) Index	1. Inadequate = 0 - 49% of expected visits 2. Intermediate = 50 - 79% of expected visits 0. Adequate = 80 - 109% of expected visits 3. Adequate Plus = ≥ 110% of expected visits	Birth certificate data recode utilizing Birth Certificate items 30 and 31
Dependent Variables	Birth weight	1. ≤ 2499 grams 0. ≥ 2500 grams	Birth certificate data recode using Birth Certificate item 33
	Gestational age	1. < 37 weeks 0. ≥ 37 weeks	Birth certificate data recode using Birth Certificate item 34

Birth Certificates as a Source of Data

Examination of the quality of the available data was necessary prior to implementing the study. Birth certificates (BC) are a population-based data source that provides uniformly collected information on birth outcomes, and demographic and medical factors. BC data is the source of national statistics on birth occurrences and outcomes, including premature and low birth weight birth rates. The first standardized version of a live BC in the U.S. was developed in 1900 (Gould, 1999). The standard version, including a minimum data set required by all states, has been revised twelve times, and has included data on maternal and infant variables since the 1939 revision. The latest revision was in 2003; states are not required to convert to the new format until funds for training and required computer program changes are available (Northam & Knapp, 2006). Montana used the eleventh (1989) version of the U.S. Standard Certificate of Live Birth through 2007; the 2003 version was adopted in January of 2008 (Edgar, 2007).

The 1989 U.S. Standard Certificate of Live Birth included fields for reporting demographic data on the newborn, mother, and father. Demographic data includes the date, time and place of birth, the mother's state, county and town of residence, mother's date of birth, and birthplace, and the father's date of birth and birthplace. Information which is intended for "medical and health use" includes the mother's and father's race and education, the mother's pregnancy history, marital status, and information regarding the outcome of the present pregnancy. This information includes the month pregnancy prenatal care began, number of prenatal visits, birth weight, clinical estimate of gestation, APGAR scores and whether or not the mother was transferred to another health facility

prior to delivery or if the infant was transferred. Checklists of medical and other risk factors for the pregnancy, obstetric procedures, complications of labor and delivery, method of delivery, abnormal conditions of the newborn, and congenital anomalies of the infant provide the certifiers or attendants responsible for completing the forms to report on eighty conditions or circumstances of the pregnancy and delivery (DHHS, 2003).

State vital statistics registrars are required by federal and state law to assure the quality and confidentiality of vital statistics (NCHS, 2007b). NCHS recommends that states train and certify BC data collectors, but funding to support this practice must be provided by the state and is inconsistent (Northam & Knapp, 2006). In Montana, as in other states and communities, training often consists of one medical records clerk training another, with little or no reference to training materials.

The accuracy of BCs must be considered prior to making a decision to use them as a data source. Accuracy is impacted by the validity and reliability of measures (Gerstman, 1998; Northam & Knapp, 2006), and both should be assessed prior to use.

Validity

Validity can be defined as the extent to which available data supports a stated inference (Shadish, Cook, & Campbell, 2002). Validity assessment usually consists of content, criterion related, and construct validity measures (Hulley et al., 2001); given the type of information gathered on the birth certificates, there is little interpretation regarding content or construct validity. Birth certificates are primarily assessed with criterion-related validity, which compares information for a tool being assessed against a "gold standard." The most frequently used gold standard against which BCs are compared is the medical record (P. Buescher & Ward, 1992; DiGiuseppe, Aron, Ranbom,

Harper, & Rosenthal, 2002; Lydon-Rochelle et al., 2005). Other standards against which BCs are evaluated include medical record abstractions (Dobie et al., 1998; Roohan et al., 2003), face to face interviews (Braveman, Pearl, Egerter, Marchi, & Williams, 1998), and birth defect registries (Watkins et al., 1996). Northam and Knapp argued that a single gold standard source may not be appropriate for BC assessment, because different data sources may be the most accurate for different variables. For example, both the BC and the medical record may report no alcohol use for a pregnant woman, but a maternal survey or face to face interview of a mother may result in a mother admitting to alcohol use. Therefore, criterion referenced validation may be flawed, as both the BC and the medical record may contain the same information but both may be wrong (Northam, Polancich, & Restrepo, 2003).

Roohan and colleagues examined the validity of BC data in New York, using medical record abstraction completed by a trained registered nurse as the "gold standard." Sensitivity, specificity, positive predictive values, and negative predictive values were calculated for seven categories including risk factors related to pregnancy and infant information. Sensitivity was defined as "a measure of the ability of the BC data to accurately detail conditions reported in the medical record" (Roohan et al., 2003, p. 338). Sensitivity was high for birth weight (100%), timing of the date of initiation of prenatal care ± one week (76%), and tobacco (89%) and alcohol use (86%) (Roohan et al., 2003). DiGiuseppe and colleagues also reported sensitivity of the birth certificate data to medical records on birth weight, tobacco and alcohol, and reported very high sensitivity (99.4%) for birth weight, but lower sensitivity for tobacco and alcohol use, reported at

72.2% and 23.3%, respectively (DiGiuseppe, Aron, Ranbom, Harper, & Rosenthal, 2002).

Small sample sizes have been identified as limitations in assessing reliability and validity of BCs (P. Buescher, Taylor, Davis, & Bowling, 1993; Roohan et al., 2003). In studies based on larger samples, the limited geographic location or hospital type (i.e. military, public, private) were reported as affecting the generalizability of findings (DiGiuseppe, Aron, Ranbom, Harper, & Rosenthal, 2002; Dobie et al., 1998). Methodological decisions regarding exclusion of negative items from the analysis and decisions regarding categorization also may have limited the comparability of the findings.

Reliability

Reliability refers to consistency of measurement, and is usually estimated by assessing stability (repeatability) or equivalence (Murdaugh, 1986). Measures of stability are rarely reported on BCs, due in part to the nature of the data reported on the certificate, which is both point in time and typically focuses on individual variables such as weight and gestational age. Other measures of stability such as inter-rater consistency, which would assess the degree to which two individuals agree and respond the same to a particular item on a tool, and intra-rater reliability, which would indicate the degree to which an individual responsible for data entry would record the same information at different times, are also not frequently reported; Northam and Knapp reported finding no studies including inter-rater *or* intra-rater reliability in their review of the literature (Northam & Knapp, 2006, p. 6).

The most frequently reported assessment of BC reliability is based on the concept of equivalence, which is the degree to which two data sources are comparable. In reliability assessment, neither data source is considered the standard. Equivalence is reported using Cohen's kappa statistic or other measure of agreement between two data sources (Northam & Knapp, 2006). Cohen's kappa statistic reports the strength of agreement between two data sets and ranges from 0 to 1, with 0 indicating agreement due to chance alone and 1 being excellent agreement between two measures. Reliability of BCs is variable based on the data source used as the comparison. Smulian and colleagues (2001) identified four primary data sources for BC data: the hospital maternal medical record, the infant medical record, the physician office prenatal record, and a worksheet completed by the parent(s) before discharge (Smulian et al., 2001). If the comparison data source is the hospital medical record, reliability findings may use the same statistics reported for content validity.

Smulian and colleagues surveyed those responsible for completing the BCs, and determined that there was limited consistency between facilities for what data source was used for each data piece. For example, 63% of the hospitals reported retrieving the mother's name from the mother's medical record, 13% from the physician's office prenatal record, and 24% from the parent work sheet. Variation existed not only between hospitals, but also between individuals employed at each hospital; survey respondents reported using combinations of data sources to complete various fields, with individual preference affecting decisions on which data set to use (Smulian et al., 2001).

The reliability of birth outcome measures that were used in the present study are generally considered adequate. When compared to maternal hospital records, birth weight

was accurately reported on birth certificates more than 95% of the time; a kappa score of 0.976 was reported by Diguiseppe and associates (P. Buescher, Taylor, Davis, & Bowling, 1993; DiGiuseppe, Aron, Ranbom, Harper, & Rosenthal, 2002). Gestational age reporting also had good reliability, with True Positive Fraction of 72.1 (Lydon-Rochelle et al., 2005), sensitivity of 93.5% (Josberger, 2007), and a kappa estimate of .72 (DiGiuseppe, Aron, Ranbom, Harper, & Rosenthal, 2002).

The reliability of reported substance use varies by substance. Reporting of tobacco use is adequately reliable, with estimates of k = .766 (DiGiuseppe, Aron, Ranbom, Harper, & Rosenthal, 2002), sensitivity of 74% (Piper et al., 1993), and percentage of exact agreement (PEA) at 91.9 % (P. Buescher, Taylor, Davis, & Bowling, 1993). The accuracy of reports of alcohol use were more variable, with a kappa estimate of .335 (DiGiuseppe, Aron, Ranbom, Harper, & Rosenthal, 2002), sensitivity of 31 % (Piper et al., 1993), and PEA at 84.4 % (P. Buescher, Taylor, Davis, & Bowling, 1993). Some authors of studies reporting tobacco and alcohol use cautioned that accuracy was calculated on very small numbers of positive responses, and that alcohol and tobacco use may not be reliably reported (P. Buescher, Taylor, Davis, & Bowling, 1993; DiGiuseppe, Aron, Ranbom, Harper, & Rosenthal, 2002). Accuracy of reporting for maternal risk factors and complications were also varied, with the accuracy of reporting of pregnancy induced hypertension being poor to fair with kappa estimates of .404 (DiGiuseppe, Aron, Ranbom, Harper, & Rosenthal, 2002) and .58 (Dobie et al., 1998), and the incidence of diabetes during pregnancy kappa estimates ranging from .43 (Dobie et al., 1998) to .54 (DiGiuseppe, Aron, Ranbom, Harper, & Rosenthal, 2002).

Data Analysis Plans

Statistical analysis for this project used the Statistical Program for Social Sciences (SPSS) 17.0. A p-value of <0.05 was the criterion to determine statistical significance.

Analysis of Study Aims

Analysis was conducted to examine the three study aims, as described below.

Aim 1: Determine the predictive ability of six demographic measures to identify low birth weight and premature births in Montana.

> Hypothesis: Women who are less than twenty years of age or greater than thirty four years of age, are non-Caucasian, have less than a high school education, are unmarried, who live in rural or frontier communities or who had Medicaid as a payer for the birth, are more likely to experience poor birth outcomes, specifically low birth weight and/or premature births.

Aim 1 was examined using two analysis methods: Receiving Operation Characteristics (ROC) Curve and logistic regression. ROC is a data mining method which Goodwin and associates promote as a reasonable method with which to examine relationships between data indicators identified in the literature and premature births (L. Goodwin et al., 2001). Data mining techniques are sometimes likened to a "fishing expedition", not subject to or congruent with scientific method. However, in large sample, data mining may be a reasonable scientific approach, because statistical assumptions and sample to population inferences are largely unnecessary, with samples large enough to represent the population, such as the case in the present research (L. Goodwin, VanDyne, Lin, & Talbert, 2003). Goodwin reports that data mining resembles exploratory data analysis, except that data mining, unlike traditional analysis that is

hypothesis driven, is "discovery-driven" searching for patterns in the data. McClean reported on efforts to predict premature births through preterm screening tools; these tools resulted in positive predictive values (PPVs) of only 17.0 to 38.2 (McLean, Walters, & Smith, 1993). Woolery and associates reported much higher PPVs, ranging from 49.2 – 71.2%, when using data mining techniques including demographic indicators (Woolery & Grzymala-Busse, 1994). Goodwin described the use of binary measures i.e. premature or not premature or low birth weight or not low birth weight, as reasonable assimilations of outcomes, especially in large data sets. Most statistical software, including SPSS 17.0, can manage large numbers of variables in data mining analysis. Inductive reasoning based on clinical knowledge and previous research is used in data mining techniques; the extensive body of literature examining preterm and low birth weight prediction makes data mining a reasonable approach.

Receiver operating characteristic (ROC) provides a visual output of multiple analysis methods including logistic regression. The output includes a graph which represents the area under the curve (AUC). The greater the accuracy of prediction, the greater the AUC, with 1.0 being perfect prediction. Perfect prediction is located on the Y axis and "chance" of 0.5 on the diagonal. In this study, similar to the 2001 Goodwin study, the true-positive rate represented the number of women who were predicted to deliver preterm and did actually have a preterm baby; the false-positive rate was the number of women who were predicted to deliver preterm but delivered a full term baby. This study also performed a separate ROC analysis for the same predictors in relation to the incidence of low birth weight birth.

In addition to performing ROC, logistic regression was also used to determine how effectively six demographic variables predict membership in two groups: women having a low birth weight birth and women having a premature births. Predictors were those already examined using the ROC. Logistic regression is a commonly used statistical technique that allows for examination of the relationship between independent or predictor variables and dependent or outcome variables. Regression analyses reveals relationships between variables, but should not be used to imply causality. Careful inclusion of independent variables, based on theoretical relationships and examination of the literature. Correlation between variables is a concern in logistic regression, and was a concern in this study, as some of the demographic indicators may be correlated; for example, younger women, specifically teen aged women are more likely to be unmarried and have less than a high school education than women over 20. Regression analysis also assumes sound measurement of independent variables; the present study's use of reliable and valid data was supportive of that assumption. The large data set addressed concerns related to the ratio of cases to independent variables.

Aim 2: Examine the impact of home visiting, after controlling for medical prenatal care, on the incidence of low birth weight and/or premature birth in high risk women Montana.

Hypothesis: High risk women receiving home visiting services and adequate prenatal care will have lower incidences of low birth weight and premature compared to high risk women who did not receive home visiting services and/or adequate prenatal care in Montana.

Correlations between risk factors and prematurity and low birth weight birth were tested with Phi coefficients. Risk factors included demographics, medical risk factors

occurring before or early in pregnancy, and behavioral risk factors available in the data set (tobacco and alcohol use). Only those risk factors significantly associated with both low birth weight and premature birth were included in the model. See Table 3 for the list of variables examined.

Table 3 **Correlation Variables**		
	Category	Description
Independent Variables	Demographic Risk	Maternal Age Maternal Race Maternal Education Marital Status Residency Medicaid Birth
	Behavioral Risk	Tobacco Use Alcohol Use
	Medical Risk	Anemia Non-Gestational Diabetes Chronic Hypertension Previous PT/Small Birth
Dependent Variables	Birth weight	≤ 2499 grams or ≥ 2500 grams
	Gestational age	< 37 weeks or ≥ 37 weeks

At risk women were grouped by adequacy of prenatal care, recognizing prenatal care receipt as a potential confounder to the analyses. The incidences of low birth weight birth and premature birth in the home visited vs. not home visited populations were examined with the Chi-Square test, a non parametric test appropriate for nominal data.

Aim 3: After controlling for adequacy of prenatal care, compare average Medicaid billed charges for infants born to high risk women who did and did not receive home visiting services during their pregnancy.

Hypothesis: The Medicaid billed charges during the first year of life for infants whose mothers received home visiting services during pregnancy will be lower than the Medicaid billed charges for infants whose mothers did not receive home visiting services.

After controlling for adequacy of prenatal care received, infant care costs for high risk women who did and did not receive home visiting services were examined with t-tests for independent samples. A summary of the analysis plans is included in Table 4.

Table 4 **Overview of Analysis Plan**

AIM	Variable	Analysis
1. Assessment of Demographic Variables as predictors of LBW or Premature Birth	Demographic • Maternal Age • Maternal Marital Status • Maternal Race • Maternal Education • Maternal Residence • Payer Source	Receiving Operations Curve Logistic Regression
2. Impact of PHHV on LBW or Premature Birth in At risk Women after controlling for Medical Prenatal Care	• Demographic Risk Factors • Behavioral Risk Factors • Medical Risk Factors	Correlations with Phi Coefficient
	• LBW Birth • Premature Birth	Non-Parametric Chi-Square
3. Comparison of Medicaid Costs between At Risk Women who did and did not receive PHHV services	Medicaid Costs • One Month Infant Costs • One Year Infant Costs	t-tests for Independent Means

Limitations of the study

Limitations to the study were attributable primarily to the retrospective nature of the research and the use of existing data. Risk factors such as homelessness, domestic violence, stress, and illicit drug use were not available in the data set. The 2003 version of the birth certificate format will provide some useful data, including payer source and maternal pre and post pregnancy weight.

Permission for the study

Notification of Study Review and Protocol/Consent Form Approval from the Oregon Health & Science University Institutional Review Board was received on November 17, 2008. Notification of study approval by the Montana Department of Public

Health and Human Services' internal review board was received July 1, 2008. A Data Use Agreement between OHSU and DPHHS in December, 2008. All data identifiers were deleted prior to receipt by the researcher. In compliance with OHSU IRB review recommendations, residency data was grouped by RUCA codes for urban, large urban and small urban communities; zip code level data was not included in the data set. Data on pregnant women and adolescents will be included in the study; this research is acceptable due to the exemption contained in 45 CFR Part 46 that states that "research involving the collection or study of existing data, documents, records or specimens" is exempt from special protections for pregnant women and children.

Managing and Storing Data

Data obtained from vital statistics, program files, and Medicaid is stored in a secure, password protected laptop.

Conflict of Interest

The investigator anticipates no financial gain from the study.

Initial Analysis

Data quality and content was examined prior to analysis. Descriptive statistics and plots were used to describe normality of sampling distribution, and identify outliers in the data. Due to quality controls employed in vital statistics collection, there were very few records with missing data.

Missing Data Analysis

There were 12092 singleton births in Montana in 2006. Birth certificate submission is required by state law, and due to the nature of the data, and the quality assurance for data submission, birth records have very little missing data. Independent

demographic variables including maternal age, race, education, residency status and marital status were missing in less than 1.0% of all births. Fifteen of the births were missing gestational age; of those, two were also missing birth weight. Two other cases were missing birth weights. These seventeen cases constituted 0.1% of the total singleton birth cohort; due to the importance of gestational age and birth weight in the study, cases missing those data elements were deleted from the data set. Characteristics of the deleted cases and cases retained in the analysis are summarized in Table 5.

Table 5 **Comparison of Deleted and Selected Cases**

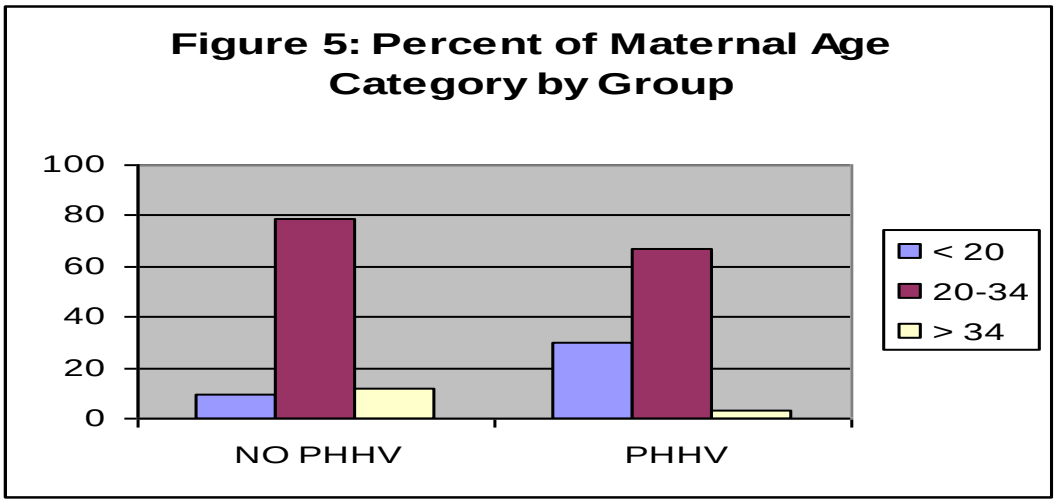
		Deleted Cases		Cases Selected for Analysis	
		N = 17	%	N = 12075	%
Maternal Age	Mean	27.6	n/a	26.8	n/a
Maternal Race	Caucasian	13	76.5	10237	84.8
	AI/AN	2	11.8	1539	12.7
	Filipino	1	5.9	34	0.3
	Missing	1	5.9	35	0.3
Marital Status	Married	6	35.3	7720	63.9
	Not Married	5	29.4	4351	36.0
	Missing	11	64.7	4	0.0
Maternal Education	< HS	4	23.5	1758	14.6
	≥ HS	13	76.5	10315	85.4
Residency	Urban	8	47.1	4531	37.5
	Large Rural	3	17.6	3088	25.6
	Small Rural	6	35.3	4450	36.9
	Missing	0	n/a	6	0.0
# PNC visits	Mean	8.64	n/a	11.15	n/a
	Missing	3	17.6	107	0.9
Trimester PNC Began	1st	15	88.2	10024	83.0
	Missing	2	11.8	189	1.6
PHHV Received	Yes	1	5.9	621	5.1
	No	16	94.1	11456	94.9
Birth Weight	Mean	3034	n/a	3320	n/a
	Missing	4	23.5	0	n/a
Gestational Age	Mean	39	n/a	38.6	n/a
	Missing	15	88.2	0	n/a

Initial Analysis

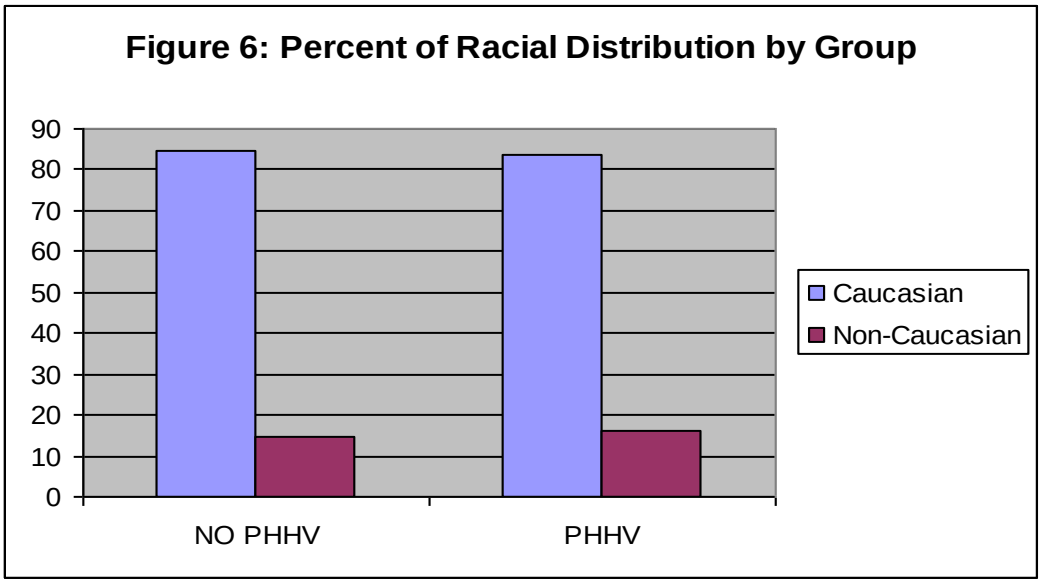
The 2006 singleton birth cohort in Montana after cases with missing data were omitted consisted of 12,075 live births. Of those births, 621 received PHHV services, 11,454 did not. Differences and similarities between the home visited and not home visited populations are described in the following section.

Demographics

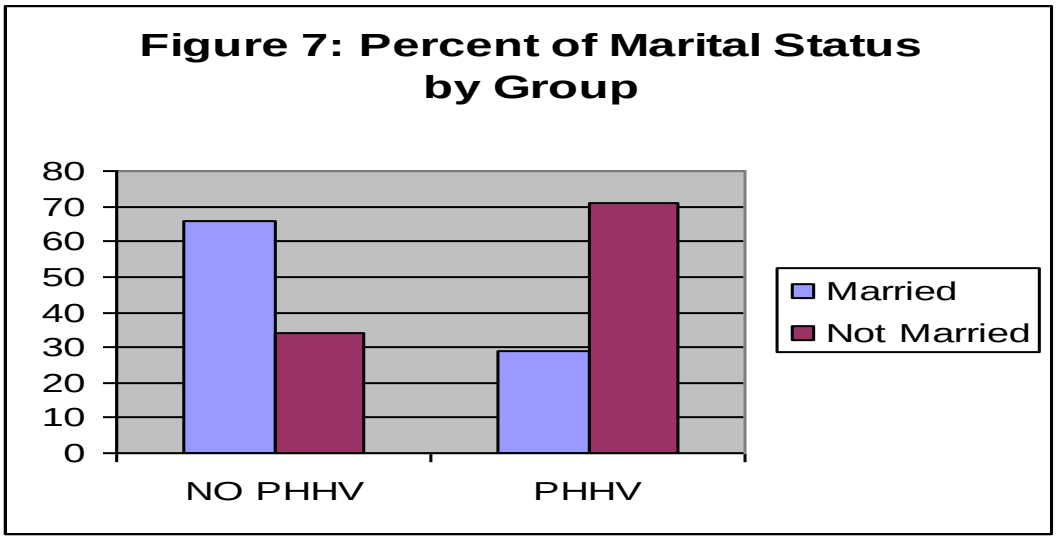
Maternal age of the singleton birth cohort ranged from 13 – 51 years of age, with a mean of 26.79. Over 30% of women receiving PHHV were less than 20 years of age; in the rest of the population less than 10% were less than 20 years of age. The program historically has targeted young, unmarried women, explaining the higher percent of young women in the program (Figure 5).



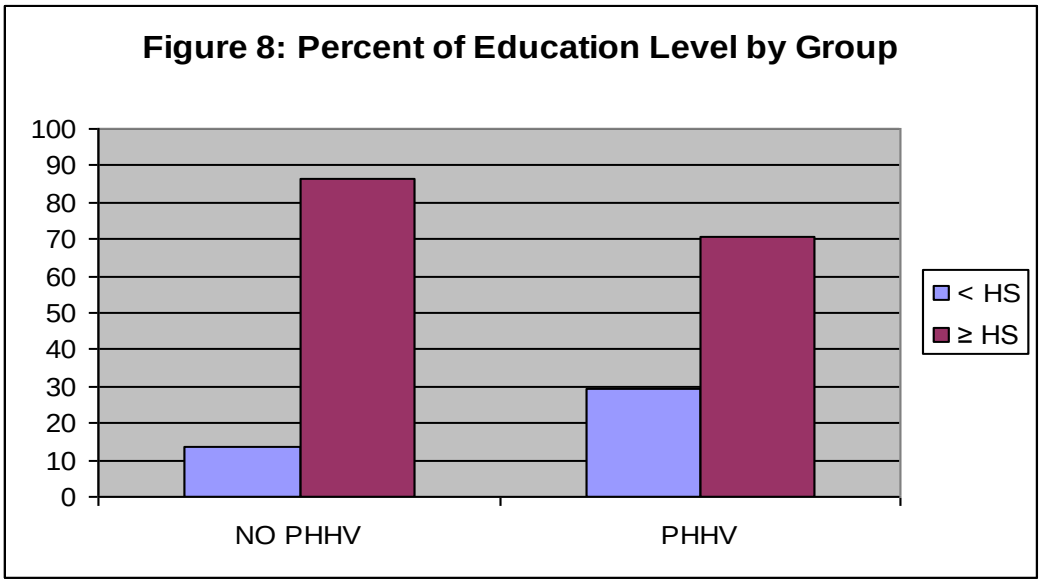
Births to Caucasians accounted for almost 85% of all births, while births to Non-Caucasians, primarily Native Americans, accounted for approximately 15%. The racial distribution in the home visited and not home visited groups were similar (Figure 6).



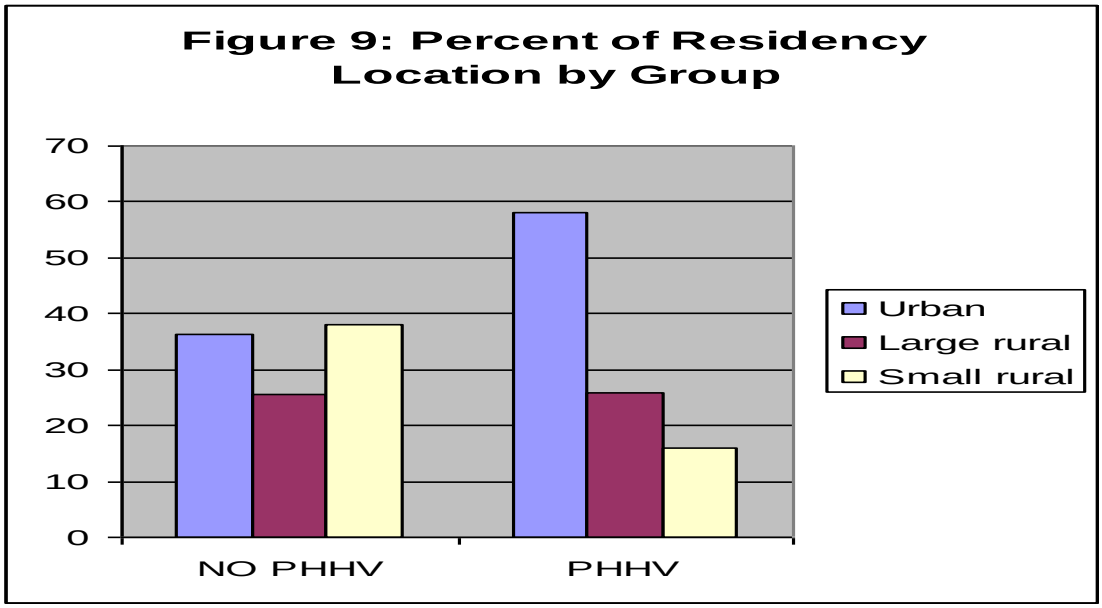
Almost 2/3 of births were to married women. Marital status differed between the PHHV and not home visited populations (Figure 7). The differences may in part be explained by target population of the program as described above.



Women who received PHHV services were also more likely to have less than a high school education compared to other women (Figure 8). Age again likely contributes to that difference.

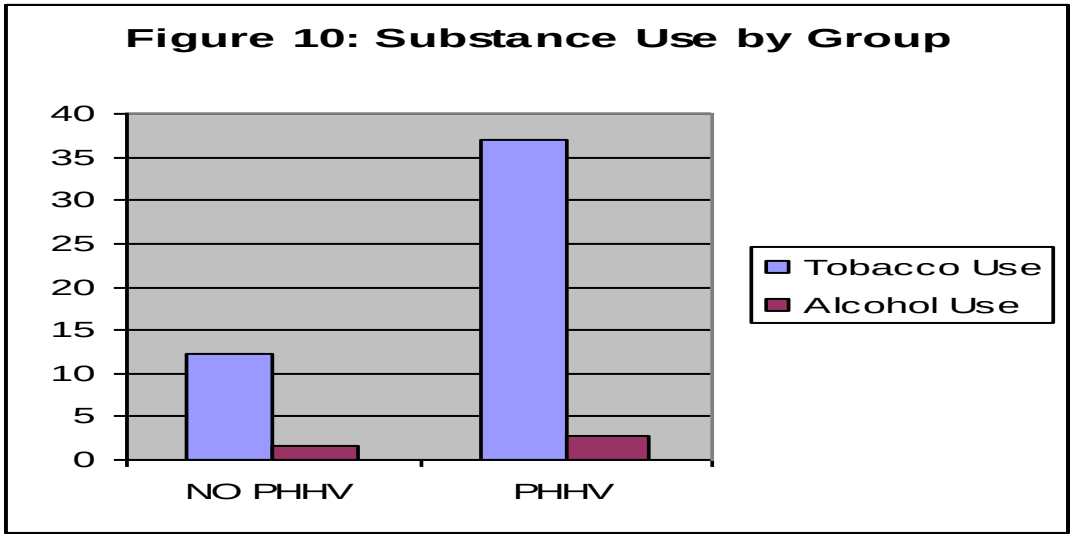


Births were roughly equally distributed to the urban, large rural and small rural areas of the state. Of the PHHV clients, more lived in rural settings and fewer in small rural settings than the rest of the population. This variation may be attributed to the location of the PHHV programs in Montana, which are primarily in larger communities due in part to availability of resources and local capacity to provide PHHV services (Figure 9).



Behavioral Risk

Tobacco use is much more prevalent in the PHHV population, with almost 37% of PHHV clients reporting tobacco use, compared to approximately 18 % in the rest of the population. Alcohol use is also reported more frequently by PHHV clients than other women (Figure 10).



Chapter IV

Results

This chapter presents the results of analyses according to the aims of the study. First, a set of demographic variables were assessed as predictors for prematurity and low birth weight using Receiving Operation Characteristics Curves, a data mining method, and logistic regression. The second aim was concerned with medical and behavioral risk factors as predictors for prematurity and low birth weight, and the impact of home visiting and prenatal care on those outcomes. Correlations between predictor variables and premature and low birth weight births were examined to identify pertinent risk indicators; the risk population was selected based on those indicators. The premature and low birth weight rates of women who received PHHV services were compared to women who did not receive home visits using non-parametric tests. For the third aim, t-tests were used to determine if there was a difference in Medicaid costs for infants born to at risk women who received PHHV to at risk women compared to those that did not receive PHHV, after controlling for adequacy of prenatal care.

Demographics as Predictors of Prematurity and Low Birth Weight

The first aim of the study was to determine the usefulness of demographic measures to predict premature birth and low birth weight in Montana. Research documents strong associations between certain demographic factors and poor pregnancy outcomes, and are used by programs, including Montana's PHHV program, as criteria for participation in the program. Six demographic variables were available in the study set and examined as predictors: maternal age, race, residency, education, marital status and payer source. These variables were examined as predictors separately for the dependent

variables of prematurity (< 37 weeks of gestation) and low birth weight (< 2500 grams) using two analytic methods: receiving operation characteristics curves and logistic regression.

Receiving Operation Characteristics Curves (ROC)

Goodwin and associate's work presented several data mining methods as reasonable approaches to examining relationships between data indicators indentified in the literature and premature births (L. Goodwin et al., 2001). ROC analyses were performed using six of the demographic indicators identified by Goodwin et al. as highly predictive, including maternal age, education, race, marital status, residency, and payer source. ROC provides a visual output of multiple analysis methods including logistic regression. In this study, similar to the 2001 Goodwin study, the true-positive rate represented the number of women who were predicted to deliver preterm and did actually have a preterm baby; the false-positive rate was the number of women who were predicted to deliver preterm but delivered a full term baby. A separate ROC analysis for the same predictors in relation to the incidence of low birth weight birth was also performed. The ROC was first performed by loading the individual predictor variables, and examining their relationship to prematurity and birthweight. Treated as individual variables, only two of the six variables (marital status and payer source) significantly impacted the area under the curve for prematurity (Table 6); three of the six variables (marital status, maternal education and payer source) significantly impacted the area under the curve for low birth weight (Table 7).

Table 6 **Area Under the Curve for Prematurity**

Test Result Variable(s)	Area	Significance	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
Maternal Age	.518	.064	.499	.537
Maternal Race	.517	.075	.498	.536
Marital status	.536***	.000	.518	.555
Maternal Education	.512	.205	.493	.531
RUCA region	.506	.529	.487	.525
Medicaid Birth	.563***	.000	.545	.582

. * Significant at $p \leq 05$
** Significant at $p \leq .01$
*** Significant at $p \leq .001$

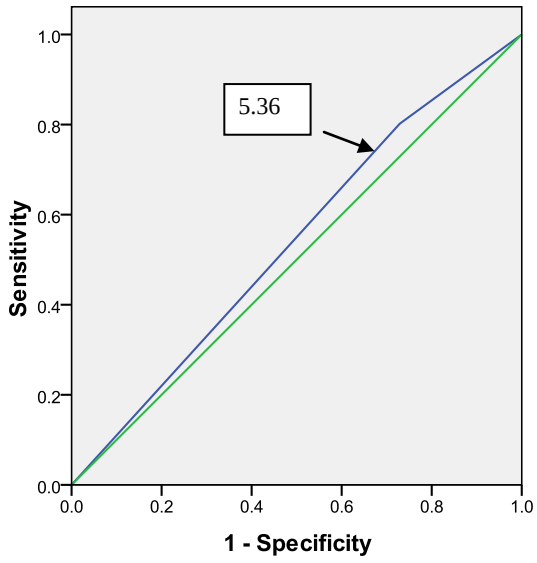
Table 7 **Area Under the Curve for Low Birth Weight**

Test Result Variable(s)	Area	Significance	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
Maternal Age	.521	.073	.498	.543
Maternal Race	.502	.875	.479	.524
Marital status	.554***	.000	.531	.577
Maternal Education	.524*	.039	.501	.547
RUCA region	.517	.145	.494	.539
Medicaid Birth	.571***	.000	.548	.593

. * Significant at $p \leq 05$
** Significant at $p \leq .01$
*** Significant at $p \leq .001$

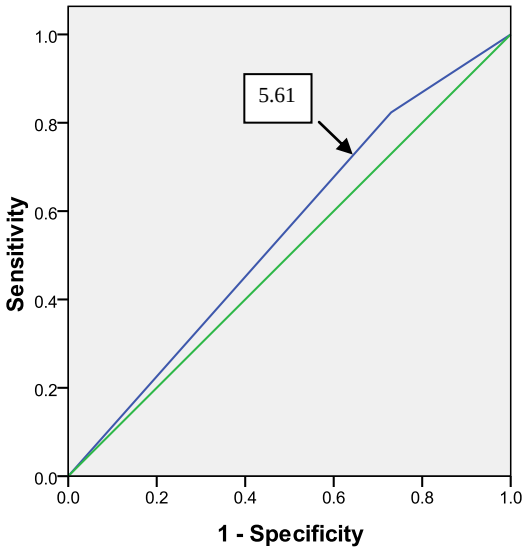
Using Goodwin's methodology, the six variables were recoded to a single variable. The results of the analyses revealed that the positive predictive value (PPV) of the six variables to predict premature birth was 0.536, which was significant at the 0.05 level (Figure 11). The PPV of the six variables to predict low birth weight was slightly higher, with a score of 5.61 (Figure 12), also significant at the 0.05 level.

Figure 11 Premature Birth



Diagonal segments are produced by ties.

Figure 12 Low Birth Weight Birth



Diagonal segments are produced by ties.

Logistic Regressions

Logistic regression is a statistical technique that examines the relationship between dependent variables or outcomes, and independent variables, also known as predictors (Field, 2000; Tabachnick & Fidell, 2001). Logistic regression was appropriate for the present study because it may be used when the predictors are correlated to one another and to the outcome variables, and when variables are discrete, rather than continuous.

Two logistic regression analyses were performed, the first between premature birth (outcome variable) and the six predictor variables examined in the ROC analysis (maternal age, education, marital status, maternal race, residency and payer source). The second regression examined the same predictors and low birth weight birth as the outcome variable (Table 8).

Table 8 **Logistic Regression Predictor and Outcome Variables**	
Category	Description
Predictors or Independent Variables	Maternal Age - <20 and >34 vs 20-3
	Maternal Race – Caucasian vs not Caucasian
	Maternal Education - < high school education vs. high school or greater
	Marital Status – married vs not married
	Residency – rural vs urban or large rural
	Payer source - Medicaid vs not Medicaid
Outcome or Dependent Variables	Birth weight - < 2500 grams vs. ≥ 2500 grams
	Gestational Age - < 37 weeks vs. ≥ 37 weeks

Forced entry, identifying no particular order was used for the variable loading in both regressions. Pair-wise exclusion instead of list-wise was used, allowing data from cases missing some items to be included in the analysis. This decision was justified due to the small amount of missing data (< .4 on each variable).

Pearson correlations document a significant relationship at the <.05 level between premature birth and five of the six predictor variables; only maternal residency was not significantly associated with prematurity (Table 9).

Table 9 **Pearson Correlations between Prematurity and Predictor Variables**							
	Gestational age	Maternal Age	Maternal Education	Marital Status	Maternal Race	Residency	Payer Source
Gestational Age	1.000						
Maternal Age	.024**	1.000					
Maternal Education	.019*	.191**	1.000				
Marital Status	.041***	.145**	.299**	1.000			
Maternal Race	.026**	.061**	.220**	.299**	1.000		
Residency	.007	.034**	.102**	.071**	.211**	1.000	
Payer Source	.072***	.064**	.296**	.547**	.262**	.061**	1.000
* Correlation significant at the .05 level ** Correlation significant at the .01 level ***Correlation significant at the .001 level							

The multiple correlation coefficient (Pearson *R)* between the predictors and gestational age was .075, and the adjusted R^2 was .005, indicating less than 1% of the variability was accounted for by the demographic factors included in the model. The impact of the

predictor variables on the regression variance of the outcome variable of prematurity was statistically significant ($F_{(6, 12027)} = 11.312$, $p < .001$).

Significant correlations were also identified between predictor variables, however, follow up collinearity diagnostics revealed no variance proportions above .80, and none indicating dependence between variables. Two variables, maternal age and payer source had significant unique association to premature birth. Payer source was the variable most strongly associated to prematurity, as evidenced by the standardized coefficient β, and zero order which described correlations between all variables, including the outcome variable (Table 10).

Table 10 **Coefficient Relationship to Prematurity**

	Unstandardized Coefficients		Standardized Coefficients			
	B	Standard Error	Beta	t	Sig.	Zero Order
Constant	.064	.004		16.246	.000	
Maternal Age	.014	.006	.021	2.244*	.025	.024
Maternal Education	-.006	.008	-.008	-.803	.422	.019
Marital Status	.000	.006	.000	-.035	.972	.041
Maternal Race	.006	.008	.008	.797	.425	.026
Residency	.001	.005	.002	.171	.864	.007
Payer Source	.040	.006	.071	6.370*	.000	.072

* Correlation significant at the .05 level

The second logistic regression examined low birth weight birth in relation to the same six variables. Pearson correlations document a significant relationship at the <.05 level between premature birth and five of the six predictor variables; maternal race was not significantly associated with low birth weight (Table 11).

Table 11 **Pearson Correlations between Low Birth Weight and Predictor Variables**							
	Birth Weight	Maternal Age	Maternal Education	Marital Status	Maternal Race	Residency	Payer Source
Birth Weight	1.000						
Maternal Age	.023**	1.000					
Maternal Education	.031***	.191**	1.000				
Marital Status	.051***	.145**	.299**	1.000			
Maternal Race	.002	.061**	.220**	.299**	1.000		
Residency	.017*	.034**	.102**	.071**	.211**	1.000	
Payer Source	.066***	.064**	.296**	.547**	.262**	.061**	1.000
* Correlation significant at the .05 level ** Correlation significant at the .01 level *** Correlation significant at the .001 level							

The multiple correlation coefficient (Pearson *R)* between the predictors and gestational age was also .075, and the adjusted R^2 was .005, the same as for prematurity, indicating less than 1% of the variability was accounted for by the demographic factors included in the model. The impact of the predictor variables on the regression variance of the outcome variable of low birth weight was statistically significant ($F_{(6, 12027)} = 11.479$, $p < .001$). Significant correlations between the predictor variables were discussed previously.

Three variables, marital status, maternal race and payer source had significant unique association to low birth weight birth. Payer source was the variable most strongly associated to low birth weight, as evidenced by the standardized coefficient β, and zero order which described correlations between all variables, including the outcome variable (Table 12).

Table 12 **Coefficient Relationship to Low Birth Weight**						
	Unstandardized Coefficients		Standardized Coefficients			
	B	Standard Error	Beta	t	Sig.	Zero Order
Constant	.038	.003		11.688	.000	
Maternal Age	.009	.005	.016	1.701	.089	.023
Maternal Education	.005	.006	.008	.844	.399	.031
Marital Status	.011	.005	.022	1.998*	.046	.051
Maternal Race	-.016	.006	-.025	-2.564*	.010	.002
Residency	.008	.004	.016	1.692	.091	.017
Payer Source	.026	.005	.056	5.055*	.000	.066
* Correlation significant at the .05 level						

The Durbin Watson Test, measuring for correlations between errors, is used to indicate if adjacent residuals are correlated. A basic assumption of regression is that residuals are independent. Values above 2 indicate a negative correlation and below 2 a positive correlation; cut off levels vary based on the number of predictors and the number of observations in the study. In the present study, the Durbin Watson test score was 1.093 for prematurity and 1.229 for low birth weight., both above the 1.0 cut-off recommended as a point of concern (Field, 2000). Because the values are close to the cut off, attention was given to the potential of committing a Type 1 error, by assuming there were differences between the groups when they may, instead, be explained in part by correlations between errors. This test was considered when interpreting the results of the regressions analyses, which indicated statistical significance of the model for both prematurity and low birth weight prediction. The hypothesis that demographic factors are useful predictors for prematurity and low birth weight is supported by the f-statistics; however potential correlation of errors and the very small amount of variance explained

by the predictor variables challenge the plausibility of the assumption that demographics are useful predictors for prematurity and low birth weight birth.

Impact of Home Visiting on Low Birth Weight and/or Premature Birth

The second aim of the study was to examine the impact of home visiting, after controlling for medical prenatal care, on the incidence of premature or low birth weight birth in high risk women Montana. An important consideration of this study was that women receiving PHHV services should be compared to similarly at risk women, as comparison in the literature frequently examines outcomes compared to all women not receiving services, including low risk women who would not be eligible for services as well as high risk women. Montana's PHHV program targets women at demographic risk, behavioral risk due to substance use (tobacco and alcohol), and medical risk identifiable early in pregnancy such as anemia, chronic hypertension, and history of a previous preterm birth.

Correlations between gestational age (< 37 weeks gestation vs. ≥ 37 weeks gestation) and birth weight (<2500 grams vs. ≥ 2500 grams) and risk factors listed above were tested using Phi coefficients. Maternal age, education, marital status, payer source, maternal smoking, chronic hypertension, and history of previous small infant were significantly correlated with both prematurity and low birth weight. Maternal race, residency, maternal drinking, anemia and non-gestational diabetes were not significantly correlated with both birth outcome variables (Table 13).

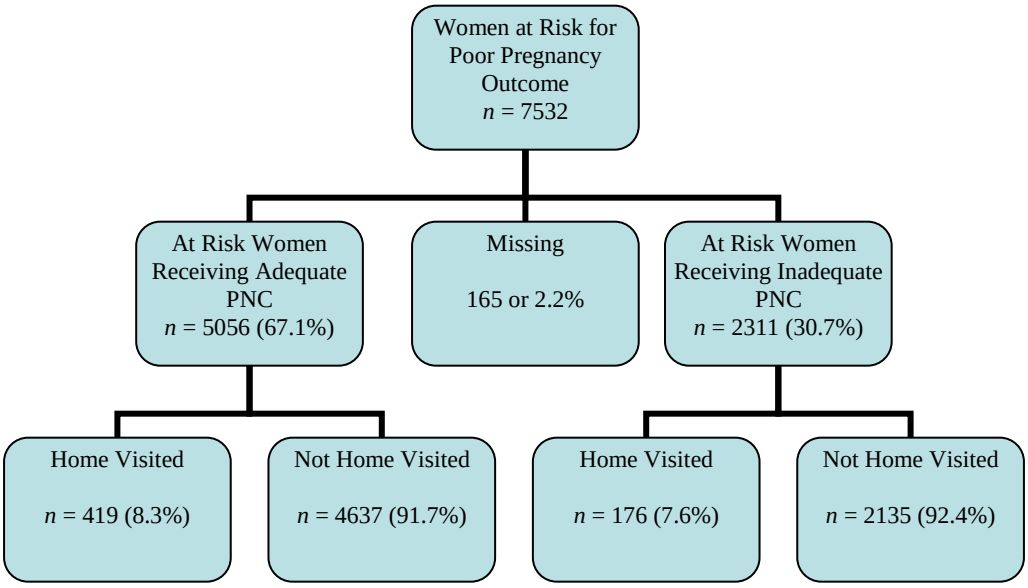
Table 13 **Phi Coefficient Correlations between Gestational Age and Birth Weight and Risk Factors**				
	Gestational Age Phi coefficient	Significance	Birth Weight Phi coefficient	Significance
Maternal Age	.024*	.007	.023*	.011
Maternal Race	.026*	.004	.002	.805
Maternal Education	.019*	.040	.031**	.001
Marital status	.041**	.000	.051**	.000
Residency	.007	.415	.017	.065
Medicaid Birth	.072**	.000	.066**	.000
Maternal Smoking	.028*	.002	.077**	.000
Maternal Drinking	.000	.988	.014	.120
Anemia	-.017	.066	.010	.279
Non-gestational Diabetes	-.053**	.000	-.007	.414
Hypertension, Chronic	.045**	.000	.040**	.000
Previous Small Infant	.072**	.000	.097**	.000
* Correlation significant at the .05 level ** Correlation significant at the .01 level				

Only the variables significantly correlated with *both* premature and low birth weight birth were selected as risk factors for the purpose of this study. Based on those seven risk factors, 7532 or 62.4% of the study population were at risk for poor pregnancy outcome; of those, 601 received home visiting services. The demographic factors, prenatal care characteristics, and behavioral risk factors for “at risk” women who did and did not receive home visiting services are summarized in Table 14.

Table 14 **Women Identified at Risk based on Age, Martial Status, Education, Payer source, tobacco use, Chronic Hypertension or History of Previous Preterm Birth (N = 7532)**					
		No HV N = 6931		PHHV N = 601	
		n	%	n	%
Maternal Age	< 20 yrs	1083	15.6	187	31.1
	20-34 yrs	4515	65.1	394	65.6
	>34 yrs	1333	19.2	20	3.3
Average Age	Mean age in years	26.34	(*sd* = 6.82)	22.7	(*sd* = 5.06)
Race	Caucasian	5417	78.2	500	83.2
	Not Caucasian	1490	21.5	99	16.5
Marital status	Married	3020	43.6	158	26.3
	Not Married	3910	56.4	441	73.4
Maternal Ed	< 12	1576	22.7	182	30.3
	≥12	5353	77.2	419	69.7
Residence	Urban	2384	34.4	349	58.1
	Large Rural	1584	22.9	157	26.1
	Small Rural	2959	42.7	95	15.8
# PNC Visits	Mean visits	10.64	(*sd* = 4.17)	11.45	(*sd* = 4.53)
PNC Began in 1st Trimester		5392	77.8	470	78.2
Tobacco Use		1967	28.4	229	38.1
Chronic Hyper		88	1.3	6	1.0
Previous Small Infant		170	2.5	12	2.0
Medicaid Birth		4313	62.2	561	93.3

Of the 7532 women at risk for poor pregnancy outcome, 5056 or 67% received adequate prenatal care. Of those, 419 (8.3 %) received PHHV services and 4637 (91.7%) did not. There were 2311 women who received inadequate prenatal care, of those, 176 (7.6%) received home visiting services, and 2135 (92.4%) did not. A schematic outlining the above is included as Figure 13.

Figure 13 Adequacy of PNC Received and Home Visit status



Based on research which presents receipt of prenatal care as a predictor of improved pregnancy outcomes (Herbst, Mercer, Beazley, Meyer, & Carr, 2003; Vintzileos, Ananth, Smulian, Scorza, & Knuppel, 2002), receipt of prenatal care was recognized as a potential confounder in the study. Adequate prenatal care was defined as receipt of 80% or more of the recommended prenatal visits as described by Kotelchuck (1994) using the Adequacy of Prenatal Care Utilization (APNCU) index. Examination of the data revealed significant differences in the incidence of prematurity ($X^2_{(1)} = 30.049$, p = .000) in high risk women based on adequacy of prenatal care received; however, the difference was unexpected, with women receiving adequate prenatal care having a higher rate of prematurity (n = 556 or 11.0%) than those receiving inadequate prenatal care (n = 160 or 6.9%). The differences between the incidence of low birth weight birth to high risk women, based on adequacy of prenatal care received, was not significant ($X^2_{(1)} = .463$, p = .496), but again, women with adequate prenatal care had higher incidence of low birth weight birth (n = 352 or 6.9%) than women who received inadequate prenatal

care (n = 151 or 6.5%). The unexpected outcomes do not support findings in the literature, but the significant differences justified controlling for adequacy of prenatal care received in subsequent analyses.

For women who received adequate prenatal care, the odds of having a premature or low birth weight birth were very similar for women who did and did not receive PHHV services; the odds ratio for premature birth was 1.08, and for low birth weight birth 0.91. The prematurity and low birth weight rates for at risk women who received adequate prenatal care are summarized in Table 15.

Table 15 **Birth Outcomes for At Risk Women who Received Adequate PNC n = 5056**			
		Receipt of PHHV Services	
		Yes	No
		n = 419	*n* = 4637
Premature	Yes	49 (11.7%)	507 (10.9%)
	No	370	4130
LBW	Yes	27 (7.3%)	325 (7.9%)
	No	392	4312

Chi-Square tests were performed to examine the link between prematurity and PHHV, and low birth weight birth and PHHV. The links between prematurity and PHHV ($X^2_{(1)} = .227$, $p = .634$) and between low birth weight birth and PHHV ($X^2_{(1)} = .189$, p = .663) were not statistically significant.

For at risk women with *inadequate* prenatal care, those who received PHHV services were more likely to have a premature birth (OR 1.18) and less likely to have a low birth weight birth (OR 0.66) than women who did not receive PHHV services. The prematurity and low birth weight rates for at risk women who received *inadequate* prenatal care are summarized in Table 16. Chi-Square tests were performed to examine the link between prematurity and PHHV, and low birth weight birth and PHHV. For women who received *inadequate* PNC, the links between prematurity and PHHV ($X^2_{(1)} =$

.314, p = .575) and between low birth weight birth and PHHV ($X^2_{(1)}$ = 1.234, p = .267) were not statistically significant.

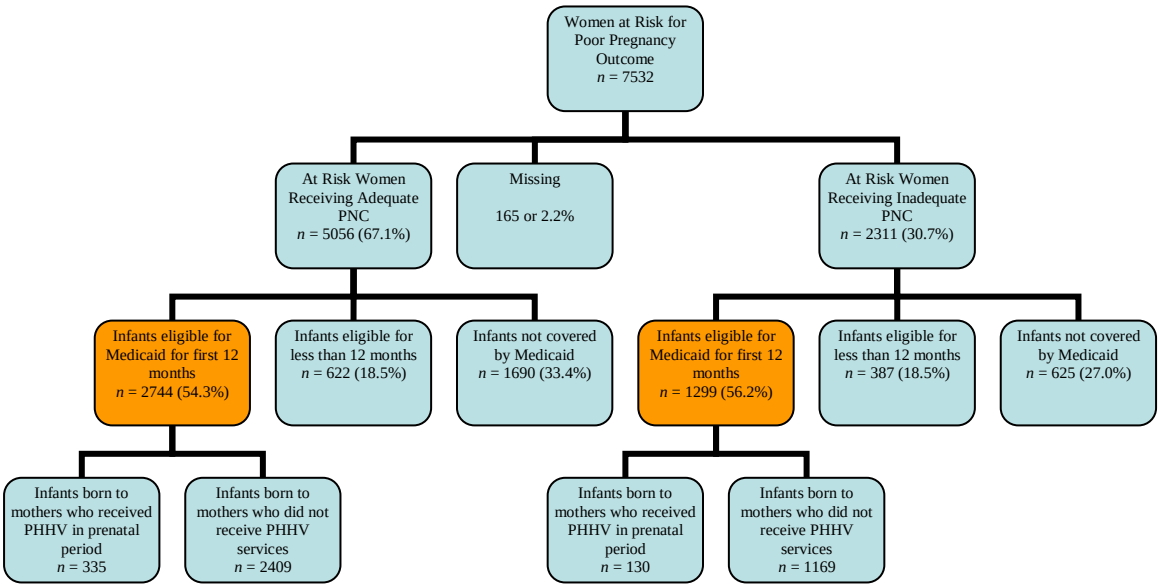
Table 16 **Birth Outcomes for At Risk Women who Received Inadequate PNC n = 2311**			
		Receipt of PHHV Services	
		Yes	No
		n = 176	n = 2135
Premature	Yes	14 (8.0 %)	146 (6.8 %)
	No	162	1989
LBW	Yes	8 (4.5%)	143 (6.7 %)
	No	168	1992

The hypotheses that home visiting services would decrease the incidence of low birth weight and premature births among high risk women were not supported. It was interesting to note that at risk women who received PHHV services (n = 599) had significantly more prenatal visits (m = 11.45, sd = 4.53) than women who did not receive home visiting services (n = 6860, m = 10.64, sd = 4.17) ($t_{(7457)}$ = 4.553, p = .000).

Medicaid Costs

The third aim asked whether there was a difference in Medicaid costs for infants born to at risk women who received PHHV compared to at risk women who did not receive PHHV. For the purposes of these analyses, only infants who were eligible for Medicaid for the entire first twelve months of life were included. Of the 5056 women who received adequate prenatal care, 2744 or 54.3% of infants were eligible for Medicaid for the entire first year of their lives. Of the 2311 women who received inadequate prenatal care, 1299 or 56.2% were eligible for the entire first year of their lives. A schematic outlining the above is included as Figure 14.

Figure 14 Medicaid Eligibility for Infants Born to High Risk Women



Initial examination of the data revealed very large ranges of costs for both the first month of life and the first year. Costs ranged from $0 to $293,689 for the first month of life, to $0 to $640,175 for the first year of life. Low range costs were attributable to third party reimbursement coverage for some infant costs; Medicaid is the payer of last resort and Medicaid does not pay for services that are covered by alternative health coverage (AKA third party reimbursement). High range costs were attributable to severe illness or disability of infants. Based on the full range of costs, the mean cost for the first month of life for infants born to women who received adequate prenatal care and PHHV was higher, *mean* = $3,575 (*sd* = $13,680), compared to *mean* = $3358 (*sd* = $13,042) for infants born to women who did not receive PHHV services. The difference of $217 was not statistically significant ($t_{(2699)} = .283$, $p = .777$). The cost for the first year of life (inclusive of first month charges) for infants whose mothers received PHHV services was also higher *mean* = $7,833 (sd = $39,132), compared to costs for infants whose

mothers did not receive home visiting *mean* = $5,782 (sd = $21,093); the difference of $2,051 was again not statistically significant ($t_{(2699)} = .283$, $p = .777$) (Table 17).

Table 17 **Medicaid Infant Costs for At Risk Women who Received Adequate PNC**

	PHHV Received	*n*	*Mean*	*SD*
Infant Costs For First Month of Life	Yes	333	$3575	13680
	No	2368	$3358	13042
Infant Costs for First Year of Life	Yes	335	$7833	39132
	No	2409	$5782	21093

The very large cost range resulted in large standard deviations that made interpretation of the data difficult. In an attempt to address this issue, infant costs of <$1,000 and >$12,000 were treated as outliers and removed from the analysis. The resulting data included 2,383 infants (constituting a decrease of 14%, with 7% on either end of the spectrum). Analysis using this limited data set resulted in mean infants costs for the first month for infant born to women who received PHHV services of $1,457 (*sd* = $1,123), compared to $1,392 (*sd* = $1,201) for infants born to women who did not receive PHHV services. The mean difference of $65 was not statistically significant ($t_{(2365)} = .882$, $p = .378$). The mean cost for the first year of life (inclusive of first month charges) using the same limited data set was $3,159 (*sd* = $1,800) for infants born to women who received PHHV services, compared to $2,890 (*sd* = $1,918) of infants born to women who did not received PHHV services; the mean difference of $268 was statistically significant ($t_{(2381)} = 2.263$, $p = .024$) (Table 18).

Table 18 **Medicaid Infant Costs for At Risk Women who Received Adequate PNC with infant cost range limited to $1,000 to $12,000**				
	PHHV Received	*n*	*Mean*	*SD*
Infant Costs For First Month of Life	Yes	293	$1457	1123
	No	2074	$1392	1201
Infant Costs for First Year of Life	Yes	294	$3159	1800
	No	2089	$2890	1918

The significant difference in costs may be partially explained by examination of the data for evidence of medical services received during infancy. Infants whose mothers received adequate prenatal care and PHHV services (n = 294) had significantly more Medicaid claims (*mean* = 53.64, *sd* = 21.22) during the first year of life than infants born to women who received adequate prenatal care but did not receive PHHV (n = 45.87) (*mean* = 45.87, *sd* = 16.61) ($t_{(345.36)} = 6.024$, $p = .000$).

When examining the full range of costs, for at risk women who received *inadequate* prenatal care (< 80% of expected visits), infant costs at one month and one year of age were lower for those who received home visiting compared to those who did not. The differences of $1060 in the first month of life and $328 for the first year of life were not statistically significant with t-test values of $t_{(1267)} = -1.065$, $p = .287$ and $t_{(1297)} = -.191$, $p = .848$, respectively. If again using the smaller range of costs (> $1,000 and <$12,000) infant costs at one month of age were higher and at one year of age lower for those mothers who received home visiting compared to those who did not. The differences of $56 in the first month of life and $152 for the first year of life were not statistically significant with t-test values of $t_{(1119)} = .436$, $p = .663$ and $t_{(1138)} = -.765$, $p = .445$, respectively. Table 19 summarizes the findings.

Table 19 **Medicaid Costs for Infants Born to At Risk Women Who Received Inadequate PNC**							
		Full Range of Costs			Infant Costs >$1,000 and < $12,000		
	PHHV Received	*n*	*Mean*	*SD*	*n*	*Mean*	*SD*
Infant One Month Costs	Yes	129	$2,160	$4,385	120	$1,544	$1,353
	No	1140	$3,221	$11,213	1001	$1,487	$1,348
Infant One Year Costs	Yes	130	$5,413	$20,820	120	$2,967	$1,790
	No	1169	$5,742	$18,317	1020	$3,119	$2,090

The hypothesis that PHHV in the prenatal period decreases Medicaid costs for infant care was not supported.

Chapter V

Discussion

The purpose of the study was to examine the effect of home visiting on birth outcomes in Montana, specifically the incidence of low birth weight and premature births. Home visiting is a method of service delivery with a long history in the U.S. and in Montana. The service, which is resource intensive, is supported by public dollars. This study was developed and implemented in order to assist in the evaluation of the program, and to help guide future policy development and program implementation.

The study was designed to address three major aims. Aim 1 evaluated the effectiveness of demographic measures to predict the occurrence of low birth weight and premature births in Montana in 2006. Aim 2 examined the associations between the provision of home visiting and receipt of medical prenatal care and the incidences of premature and low birth weight births in Montana, and Aim 3 assessed the differences of Medicaid costs for infants born to mothers who did or did not receive home visiting services.

Predicting premature and LBW births

Prediction of poor birth outcomes, specifically premature and low birth weight births, is important to effective program planning. Home visiting is resource intensive service, and targeting programs to serve those most and need and those who will most likely benefit from the services is recommended by many home visiting experts. In Montana, home visiting services target pregnant women who are identified at risk based on demographic as well as medical risk factors. Because some medical risk factors may not be apparent early in the pregnancy, demographic factors are frequently used as risk

indicators. The predictive capacity of demographics to identify at prematurity and low birth weight birth was examined both to assess the usefulness of those measures for client recruitment and to assist in the selection of women who did not receive home visiting services to use as a comparison group.

Two analytic methods, receiving operations characteristics (ROC) curves and logistic regression were used for Aim 1, to examine six demographic factors' association with premature and low birth weight births. Goodwin and colleagues assert that ROC is one of several data mining techniques that can be effectively used for knowledge development in nursing and other health research fields. Their finding that demographic indicators could be effectively used to predict poor birth outcomes was not replicated in the present study. Goodwin and colleagues reported that seven demographic factors increased the accurate prediction of premature birth from 0.50, which represents chance occurrence, to 0.72. This constituted a 22% improvement in the prediction of premature birth, similar to or sometimes better than predictive accuracy using other, often more expensive and invasive tools including completion of risk assessment tools and laboratory assessments. The present study used six of the seven demographic measures reported by Goodwin, but found that prediction of premature birth was improved only slightly, to 0.536 or 3.6% better than chance and the prediction of low birth weight birth was 0.561, or 6.1% better than chance. The differences were both significant at the 0.05 level, but much lower than those reported by Goodwin and colleagues.

The difference in the findings between the present study and Goodwin's work are not easily explained. The Goodwin data set had 19,970 women, and the present study 12,075. A full description of the demographic characteristics of Goodwin's sample

population was not provided in any of the articles published. Available information revealed several differences between the Goodwin and Montana datasets; the premature birth rate for the population assessed was 21.9%, a very high rate of prematurity compared to 8.4% in the present study. Also, over 50% of the Goodwin population was reported to be African Americans, while births to African Americans in the Montana data set constituted only 0.5% of reported births. Based on just these two indicators, it is apparent that the population in the Goodwin study is markedly different from the present study population.

Beyond the differences between the populations studied, an obvious concern would be the present study's use of only six of the seven demographic indicators used by Goodwin. Religion, which was not available in the Montana data set, was not used as a demographic indicator in the present study, but was included in the Goodwin study. The exclusion of that variable may have contributed to the difference, but the lack of research regarding the association between religious affiliation and birth outcomes provided rationale for the exclusion of the item. Recent studies propose religion as a potential protective factor; two studies reported that women who attend religious services were less likely to use tobacco, alcohol, or other substances (Gillum & Sullins, 2008) (Page, 2008) and a third that greater religiosity contributed to improved coping thereby decreasing stress (Reichman, Hamilton, Hummer, & Padilla, 2008). Based on these findings, inclusion of religion as a risk factor may have improved predictive capacity of the model.

Goodwin noted that data quality, standardization and missing values, which are typical concerns with any research study, could negatively affect outcomes. Birth

certificate data elements used for the present study have good validity and reliability, as established in the literature, and therefore the data quality is not a plausible explanation for the difference in findings between the studies. Dimension reduction was also identified by the authors as an issue that may have unique impact on the data mining methods. Dimension reduction is the process of limiting or focusing the number of variables being considered in an analysis (Guven, 2004). The present study focused on the variables already identified by Goodwin; however, the simplification of the variables to binary responses may have diminished the specificity afforded in Goodwin's work. Goodwin reported age as a continuous variable, and all other variables as binary predictors; however, some variables had multiple response groups. For example, race was reported as yes or no for Asian, Black, White, Hispanic, American Indian, or unknown, and payer source as yes or no for private, managed care, health department or other payment source categories. In the present study race was reported only as Caucasian or Not Caucasian, due in part to the homogeneity of the Montana population, and payer source as Medicaid or non-Medicaid payer. Goodwin's multiple response categories may have contributed to increased specificity in the analysis, potentially increasing the predictive ability of the indicators. Results from the ROC analyses were shared with Dr. Goodwin, and her conclusion was that the differences in the populations was the most likely cause of the lower ROC (L. Goodwin, 2009).

Logistic regressions were performed to further investigate if demographic characteristics could accurately predict if women would have a premature and/or low birth weight birth. The analysis demonstrated that Medicaid as a payer source and marital status were the demographic factors most strongly correlated with premature and low

birth weight birth. In Montana, Medicaid birth is a reasonable proxy for low socioeconomic status; until 2007, pregnant women had to be at or below 133% of federal poverty level to qualify for Medicaid. The association between improved pregnancy outcome and marital status has been attributed to improved pregnancy intention in married women (increased inter-pregnancy intervals) (Luo, Wilkins, Platt, & Kramer, 2004) and stress reduction associated with improved financial status, internal control and emotional support in married women compared to unmarried (Kirchengast & Hartmann, 2003) (Raatikainen, Heiskanen, & Heinonen, 2006) (Weisman et al., 2008). Marital status is also associated with maternal age, with young women more likely to be unmarried (J. Martin et al., 2006).

Residency was not strongly associated with either prematurity or low birth weight birth in the present study. Some researchers documented associations between rural residency and poor birth outcomes (Hulme & Blegen, 1999), while others, notably including American Indian populations, reported poorer outcomes in urban settings (L. Baldwin et al., 2002; Grossman, Krieger, Sugarman, & Forquera, 1994). Montana's high proportion of American Indian births may have contributed to this lack of correlation between rural residency and poor birth outcomes. Maternal education was only moderately associated with poor outcomes; Montana has a high proportion of the population who have graduated from high school (90.7%) compared to the US (84.2%) (IES, 2007); this higher percentage may impact the association reported in other studies.

Maternal race is inconsistently associated with poor outcomes, with non-Caucasian race moderately associated with gestational age and weakly associated with birth weight. Much of the research examining differences by race focuses on African-

American or Hispanic populations. In Montana in 2006, American Indians account for 1539 of the 1803 or 85% of births to non-Caucasians. Research findings regarding pregnancy outcomes among the American Indian population are inconsistent, with some studies reporting higher incidence of low birth weight among American Indian populations (Grossman et al., 2002; Grossman, Krieger, Sugarman, & Forquera, 1994), and others reporting lower incidences of preterm and low birth weight birth in American Indian populations compared to the primarily Caucasian referent groups (Luo, Wilkins, Platt, & Kramer, 2004). The present study corroborates inconsistencies with findings regarding the impact of race on birth outcomes.

The ROC and logistic regression analyses both demonstrate that demographic factors alone are not sound predictors of poor pregnancy outcomes, therefore, should not be used as the only recruitment criteria to home visiting programs targeting pregnancy outcomes. The present research reinforces the notion that prediction of poor birth outcomes is a complex issue.

Birth outcomes

The second aim of the study was to determine if home visited women had lower incidences of premature and low birth weight birth as compared to a similarly at risk population. The present study provided the opportunity to create a comparison group from the entire birth cohort, rather than from a select community or practice site. The design did not allow for rigorous monitoring of service delivery, but the use of birth certificates as a data source provided validated information which allowed for comparison of populations who did and did not receive PHHV services. The correlation coefficients identified risk factors which were significantly associated with both

premature and low birth weight, and were identifiable early in pregnancy, which is necessary for recruitment early in the prenatal period. Maternal age, education, marital status, payer source, maternal smoking, chronic hypertension and a history of previous small or preterm birth were significantly associated with both premature and low birth weight birth, and were used as indicators to identify women at necessary for poor pregnancy outcomes.

A comparison of the women identified at risk using the above criteria was performed, and significant differences between the groups were found. Some of those differences can be attributed to recruitment targets for the program, for example, the PHHV program traditionally targets low income clients, explaining the higher percentage of Medicaid eligible women in the PHHV group. The program also traditionally targets young pregnant women, specifically teens, explaining not only the higher percentage of young women in the PHHV group, but also the higher percentage of PHHV clients who, because of their young age, are also less likely to have completed a high school education or to be married. PHHV programs in Montana are only partially funded by state dollars, depending upon local match and billing revenue to support program services. Because of the infrastructure necessary to support the programs, most are located in larger communities in Montana, explaining the lower percentage of non-Caucasian women from tribal communities and rural dwellers in the PHHV population. The PHHV program also targets women using substances, resulting in a higher percentage of PHHV clients using tobacco than other at risk women.

After controlling for adequacy of prenatal care received, there were no significant differences in premature and low birth weight rates for women who did and did not

receive home visiting services. Women who received adequate prenatal care and home visiting services had a prematurity rate of 11.7% and a low birth weight rate of 7.3% compared to rates of 10.9% and 7.9%, respectively, for women who did not receive home visiting services. The differences in rates may be attributed to chance, but in the absence of documented focus on factors that may be impacted by home visiting, such as nutritional risk, stress and tobacco use, it is not possible to determine if concentrated focus on those factors by the home visitor may have resulted in better results for the home visited population. These findings corroborated other research, but were important to test with Montana data, in part to answer ongoing legislative and advocate inquiries regarding outcomes. The use of the linked data set allowed for comparison of the home visited population to similarly at risk women; in the past, prematurity and low birth weight outcomes were reported only for the home visited population, with comparison, if done, to statewide data that included the PHHV population and women not eligible for PHHV services.

Medicaid costs

The third and final aim of the study was to determine if there were costs savings to Medicaid for infants, based on receipt of PHHV services by their mothers in the prenatal period. This aim was important as one of the arguments for PHHV has been that the services saved the state money by providing preventive rather than intervention services. After controlling for adequacy of prenatal care received and omitting from the analysis infant costs of <$1,000 or >$12,000, the infant care cost for the first year of life for women who received PHHV were higher (*m* = $3159, *sd* = $1800) than the cost for

infants of women who did not receive PHHV (*m* = $2890, *sd* = $1918); however, the differences were not statistically significant.

Receipt of PHHV services was associated with increased utilization of medical prenatal care (measured as number of prenatal visits) and increased utilization of medical care during infancy (measured as number of Medicaid claims in infancy). At risk women who received PHHV services had significantly more prenatal visits (*m* = 11.45, *sd* = 4.53) than women who did not receive home visiting services (*m* = 10.64, *sd* = 4.17). Infants whose mothers received PHHV services also had significantly more Medicaid claims (*m* = 53.64, *sd* = 21.22) in the first year of life than infants of mothers who did note receive home visiting services (*m* = 45.87, *sd* = 16.61). Interventions by home visitors, which continue through the first birthday, may have had an impact on increased utilization. However, the data source for infants was Medicaid claims, and targeted case management, a Medicaid services provided by home visitors, would have been reflected in the Medicaid claims for infants. Therefore, the increased number of claims in infancy may also have been at least partially attributable to the PHHV services received.

Medicaid cost savings have been a basis for funding support for the PHHV program in Montana since the program's inception (LFD, 1989), therefore, despite the lack of evidence that home visiting decreases Medicaid costs, it was important to address this issue. Olds and others document cost savings attributable to other than Medicaid costs, including savings attributed to assigned costs for observed changes in educational attainment and employment , criminal behavior, substance use, reported child abuse and neglect, teen pregnancy prevention, and use of public assistance (Aos, Lieb, Mayfield, Miller, & Pennucci, 2004; D. Olds et al., 1997; D. Olds et al., 2007). Effective

monitoring of costs savings will require other data sources. Access to WIC, AFDC, Family Planning and child abuse databases may provide useful information with which to assess cost impact of home visiting service delivery.

Strengths and Weaknesses of Study

The present study provided a valuable opportunity to compare targeted program outcomes and costs for PHHV clients to similarly at risk populations who did not receive PHHV services, using available data in a way that did not increase local contractor data collection time. Previous evaluations of the program were hampered by the inability to compare outcomes for program participants to others not receiving services, and by the lack of cost data. Partnerships with Medicaid program staff provided for the creation of a data set that allowed service and cost analyses. The research provided information that may be used by the home visiting program to determine if contractors are reaching the targeted population, and if services appear to have an impact upon targeted outcomes. Revisions of the birth certificate continue to improve the quality of the available data; the 2003 version of the US birth certificate will provide additional risk data (pre-pregnancy weight) and service delivery information (receipt of WIC services) not previously available.

The present study also allowed for program evaluation to be accomplished without affecting the delivery of services at the local level. The PHHV program is ongoing and supported by state dollars as a public health service; redirection of resources to establish a focused study, such as a randomized controlled trial (RCT) would not be an allowable use of funding. Local contractors or legislators would not support reduction of service capacity or re-direction of state dollars. The information provided by the study

will be used to modify the program in a way that would allow for improved outcomes while not appreciably diminishing the existing numbers of clients served or resources distributed. Medicaid staff have committed to ongoing matching of birth certificate, Medicaid and home visiting data, which will allow the methodology to be repeated and tracked over time, allowing program policy changes to be monitored.

The data set did not provide information regarding the number of home visits conducted per client, or other dose information including frequency and length of contact. Some research links the number of client contacts to improved outcomes, however, other research refutes that finding. A separate analysis of home visiting data conducted by state epidemiologists during the 2009 legislative session revealed that the average number of home visits conducted was 6.4 (Frick, 2009), similar to the findings reported by a meta-analysis of home visiting programs (Sweet & Appelbaum, 2004).

The data set used for the present study also did not provide include information that would have been very useful in analysis, including data regarding domestic violence, homelessness, illicit drug use, and measures for stress. The data collection tools for the PHHV program in Montana are being revised in 2009, and the new tool, which will be in use in July 2009 will include the above measures. The 2003 birth certificate version, which was implemented in 2008 in Montana, also includes new measures which will be useful in analysis, including pre-pregnancy and post delivery maternal weight and payer source for all births.

Use of Medicaid data presented a challenge due to the very large range ($0 to $640,175) for infant costs for the first year of life. The very low costs (<$1,000) present a question if infants were receiving no services or if there were other explanations for the

lack of charges. One potential explanation is that other coverage may have been available for some or all bills for infants. Medicaid is a payer of last resort, and if available, other insurance or coverage will be charged before Medicaid. Third part liability (TPL) payments were included in the linked data set, however, did not appear to fully account for infant costs compared to Medicaid amounts. Investigation with Medicaid staff revealed that paid amounts for TPL are inconsistently reported by small or new insurance firms and may not be available electronically, therefore are not always reflected in the data set. Omitting the low range cost infants from the analysis addressed the lack of data to some degree, but future research should use a more sound "cut off" for low end cost infants.

Because of the limited number of births in Montana, high end or extreme costs also present analysis challenges. Thirty five infants, or 1% of the infants whose births were covered by Medicaid in 2006 had Medicaid costs of >$100,000; five of those infants had mothers who received PHHV services during the prenatal period. Two infants had Medicaid charge in the first year of life of >$500,000 per year, with one infant's Medicaid costs totaling $640,175 for the first year of life, exceeding the next highest cost infant's charges by almost $140,000. The highest cost infant was born to a mother who received home visiting services, contributing to the extreme variation and difference in standard deviation. A priori decisions regarding inclusion or exclusion should be considered prior to future analysis.

Implications for Nursing

One of the significant findings from this study was the increase in medical prenatal visits for women who received home visiting services. Medical prenatal care has

long been associated with improved birth outcomes, although in the present study, the association was not confirmed. Coordination with medical prenatal care providers to identify clients at risk and who may benefit from home visiting services would increase the potential for PHHV programs to contact at risk populations. Education of medical professionals regarding the availability and nature of the service may increase referrals from medical providers and other programs. It is well recognized that all risk factors i.e. demographics may not be mitigated; however, home visiting services have been documented to improve referral to nutritional education programs (Russell, Britner, & Woolard, 2007; Tandon, Parillo, Jenkins, Jenkins, & Duggan, 2007), increase utilization of medical prenatal care (Bradley & Martin, 1994; Ciliska et al., 1996), decrease tobacco use (D. Olds et al., 2002) (D. Olds, Henderson, Tatelbaum, & Chamberlin, 1986)and decrease in maternal stress (Hodnett & Fredericks, 2007; Lee et al., 2009; Roman et al., 2007). These factors are associated with improved birth outcomes, and with focused attention and effort, may improve the health of pregnant women and their infants who receive PHHV services in Montana.

Medical practices and programs such as WIC may require training and support to help them identify women at risk for poor pregnancy outcomes. The American College of Obstetricians and Gynecologists recommends that prenatal care includes routine screening for substance use and domestic violence (AAP/ACOG, 2007); public health programs can assist medical providers to effectively screen by offering educational opportunities on screening tools and techniques for providers and office staff. Coordination of services by routine communication with medical providers may also improve services to pregnant women. Women receiving PHHV had more prenatal visits

than women who did not receive PHHV services; communicating this association to medical providers may encourage them to refer women who are not attending medical visits and to work with home visitors to address modifiable risks such as tobacco cessation, nutrition, and stress management. Home visiting programs must work with primary care providers to receive referrals based on medical risk such as history of previous preterm or small infant or chronic health conditions associated with poor pregnancy outcome. Social service programs and agencies with data about maternal nutritional status, stress, mental health status, and history of domestic violence can also be valuable referral sources for women who would benefit from home visiting services.

Montana's home visiting program continues to focus on the improvement of birth outcomes. Recognizing the non-significant findings in the present research, the question about whether or not the program is achieving appears to still be unanswered. However, the literature points out that costs savings and improved outcomes may become apparent much later than the first birthday, and additional datasets may be required to adequately document outcomes. Also worth considering is the caution posed by Sweet and Appelbaum, who noted that statistical significance may mean that individual family improvement or changes in small percentages of families may be lost in analysis (Sweet & Appelbaum, 2004). In small states such as Montana, small gains may result in large changes for a community.

Suggestions for Future Research

The lack of data regarding behavioral risks and home visiting dosage information were identified earlier as limitations of the study. Home visitors collect data regarding behavioral risk including substance use, indicators of stress including depression,

domestic violence and homelessness and dose information regarding the number and timing of home visits received. Confident use of this data would require testing of validity and reliability use birth certificates for data also contained within that source, and home visitor records for other data. Ongoing Medicaid record linkage would allow for longitudinal analysis of Medicaid costs for children whose mother received home visiting during pregnancy and/or for infants who received home visiting during the first year of life. Contract providers and policy makers are also interested in variability of populations served and outcomes by contractor and/or region. Qualitative analysis of patient perceptions regarding home visiting services is also an appropriate focus for future research, as findings may assist program staff to better serve the target population.

Summary

Pregnancy outcomes are important to society and the health of the public. Efforts to improve outcomes are justified and warranted. Home visiting programs have the potential to address risk factors that negatively impact pregnancy and infant development (D. Olds, Sadler, & Kitzman, 2007) Risk factors such as stress, domestic violence, and substance use may be mitigated by consistent and supportive intervention by health professionals (Herzig et al., 2006)

The present research reaffirms that there is no simple mechanism with which to accurately predict risk for premature or low birth weight birth. Neither physiologic indicators nor risk factor scoring methods provide reliable mechanisms with which to predict poor outcomes (McLean, Walters, & Smith, 1993). Demographic indicators, while frequently used as markers or indicators can not reliably be used by programs to identify women at risk for poor pregnancy outcomes. Medical and behavioral risk factors

should be included in risk criteria for home visiting programs. Several medical risk factors evident before pregnancy, including history of previous small or preterm infant baby, chronic hypertension, and low or high pre-pregnancy weight are readily available to medical providers working with clients and/or from programs working with pregnant women, such as WIC.

The study confirmed findings from other research that prediction of prematurity and low birth weight is not a simple task, and that home visiting is a complex and variable method of service delivery. The research supported previous reports that demographic factors alone are not effective predictors of poor pregnancy outcomes; therefore, home visiting programs should work with medical providers in the community to assure that clients with medical and behavioral risks are referred. The present study did not find significant differences in the incidence of premature or low birth weight birth based on receipt of home visiting services; however, the low birth weight rate was lower in home visited clients, and with concentrated effort on factors strongly associated with low birth weight, notably tobacco use, the potential for significant change in outcome exists. Home visiting services did not appear to affect Medicaid costs for infants born to women who received the services in the prenatal period, however, further investigation using additional data sources and long range Medicaid costs is warranted.

The reality of home visiting in Montana, as in many states, is that it is an ongoing service, with generalized support yet with varied goals and delivery styles. Home visiting is “ingrained” in the maternal child health services nationwide, and as such, must use existing tools and realistic methods to evaluate effectiveness, with a goal of improving what is undoubtedly, and will continue to be, an imperfect but valuable service. Public

health nurses are the primary providers of home visiting services in Montana, and arguably, in the U.S. If we are to improve the services, we must use available data to document effects. It may not be possible or wise, to force nurses to use standardized curricula or programs, potentially negatively affecting the benefits of relationships documents by Byrd and others. Even Olds recognized that programs that work in a research setting may not translate well or at all to community settings (D. Olds, Sadler, & Kitzman, 2007). Home visiting programs may best serve the maternal child health population by clearly establishing goals and objectives, and by using available data, including birth certificate and Medicaid data, to assess if programs are achieving their stated goals. Community based programs can, with the help of state partners, monitor their effectiveness and target populations or needs based on their needs.

You cannot acquire experience by making experiments. You cannot create experience. You must undergo it.

Albert Camus

References

AAP/ACOG. (1983). *Guidelines for perinatal care*. Evanston, Illinois: American Academy of Pediatrics/American College of Obstetricians and Gynecologists

AAP/ACOG. (2007). *Guidelines for Perinatal Care (6th Ed)* (6th ed.). Atlanta, GA: ACOG.

Abel, E., Kruger, M., & Burd, L. (2002). Effects of Maternal and Paternal Age on Caucasian and Native American Preterm Births and Birth Weights. *American Journal of Perinatology, 19*, 49-54.

Abrams, B., Newman, V., Key, T., & Parker, J. (1989). Maternal weight gain and preterm delivery. *Obstetrics & Gynecology, 74*(4), 577-583.

Abrams, S. (2007). Nursing the community, a look back at the 1984 dialogue between Virginia A. Henderson and Sherry L. Shamansky. *Public Health Nursing 24*(4), 382-386.

ACF. (2007). About the Children's Bureau: Administration of Children & Families, DHHS.

ACOG. (2005). *Perinatal Risks Associated with Assisted Reproductive Technology* (No. 324). ACOG Com.

Addis, A., Moretti, M., Ahmed Syed, F., Einarson, T., & Koren, G. (2001). Fetal effects of cocaine: an updated meta-analysis. *Reproductive Toxicology, 15*(4), 341-369.

Ahluwalia, I., Whitehead, N., & Bensyl, D. (2007). Pregnancy intention and contraceptive use among adult women. *Maternal & Child Health Journal, 11*(4), 347-351.

AHRQ. (2001). Poor black women who lose a mothers or sister during pregnancy are more likely to have preterm births. *Research Activities*(248), 20.

Akinbami, L., Schoendorf, K., & Kiely, J. (2000). Risk of preterm birth in multiparous teenagers. *Archives of Pediatrics & Adolescent Medicine, 154*(11), 1101-1107.

Albertsen, K., Andersen, A., Olsen, J., & Gronbaek, M. (2004). Alcohol consumption during pregnancy and the risk of preterm delivery. *American Journal of Epidemiology, 159*(2), 155-161.

Alexander, G., & Kotelchuck, M. (2001). Assessing the role and effectiveness of prenatal care: history, challenges, and directions for future research. *Public Health Reports, 116*(4), 306-316.

Alexander, J., McIntire, D., & Leveno, K. (2003). Magnesium sulfate for the prevention of eclampsia in women with mild hypertension. *Am J Obstet Gynecol 189*.

Altarac, M., & Strobino, D. (2002). Abuse during pregnancy and stress because of abuse during pregnancy and birthweight. *Journal of the American Medical Womens Association, 57*(4), 208-214.

Ananth, C., Demissie, K., Smulian, J., & Vintzileos, A. (2001). Relationship among placenta previa, fetal growth restriction, and preterm delivery: a population-based study. *Obstetrics & Gynecology, 98*(2), 299-306.

Ananth, C., Demissie, K., Smulian, J., & Vintzileos, A. (2003). Placenta previa in singleton and twin births in the United States, 1989 through 1998: a comparison of risk factor profiles and associated conditions. *American Journal of Obstetrics & Gynecology, 188*(1), 275-281.

Anderson, G., Frogner, B., Johns, R., & Reinhardt, U. (2006). Health Care Spending and Use of Information Technology in OECD Countries. *Health Affairs, 25*(3), 819-831.

Anderson, N., Brown, E., & Lyon, R. (1941). Causes of prematurity: II. Comparison of maternal histories of premature and of full term infants. *American Journal of Diseases of Children, 61*, 72.

Andres, R., & Day, M. (2000). Perinatal complications associated with maternal tobacco use. *Seminars in Neonatology, 5*(3), 231-241.

Aos, S., Lieb, R., Mayfield, J., Miller, M., & Pennucci, A. (2004). *Benefits and Costs of Prevention and Early Intervention Programs for Youth* (No. 04-07-3901). Olympia, WA: Washington State Institute for Public Policy.

Armstrong, K., Fraser, J., Dadds, M., & Morris, J. (1999). A randomized, controlled trial of nurse home visiting to vulnerable families with newborns. *Journal of Paediatrics & Child Health, 35*(3), 237-244.

ASTHO. (2006). *Bringing Home Better Birth Outcomes*. Washington, DC: Association of State and Territorial Health Officials.

ATSDR. (2000). *Toxicological Profile for Polychlorinated Biphenyls (PCBs).* Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Baeten, J., Bukusi, E., & Lambe, M. (2001). Pregnancy complications and outcomes among overweight and obese nulliparous women. *American Journal of Public Health 91*(3), 436-440.

Baldwin, K., & Chen, S. (1996). Use of Public Health Nursing Services: Relationship to Adequacy of Prenatal Care and Infant Outcome. *Public Health Nursing 13*(1), 13-20.

Baldwin, L., Grossman, D., Casey, S., Hollow, W., Sugarman, J., Freeman, W., et al. (2002). Perinatal and infant health among rural and urban American Indians/Alaska Natives. *American Journal of Public Health, 92*(9), 1491-1497.

Barlow, A., Varipatis-Baker, E., Speakman, K., Ginsburg, G., Friberg, I., Goklish, N., et al. (2006). Home-visiting intervention to improve child care among American Indian adolescent mothers: a randomized trial. *Archives of Pediatrics & Adolescent Medicine, 160*(11), 1101-1107.

Barlow, J., Davis, H., McIntosh, E., Jarrett, P., Mockford, C., & Stewart-Brown, S. (2007). Role of home visiting in improving parenting and health in families at risk of abuse and neglect: results of a multicentre randomised controlled trial and economic evaluation. *Archives of Disease in Childhood, 92*(3), 229-233.

Barnes-Boyd, C., Fordham Norr, K., & Nacion, K. W. (2001). Promoting infant health through home visiting by a nurse-managed community worker team. *Public Health Nursing, 18*(4), 225-235.

Barnet, B., Liu, J., DeVoe, M., Alperovitz-Bichell, K., & Duggan, A. (2007). Home visiting for adolescent mothers: effects on parenting, maternal life course, and primary care linkage. *Annals of Family Medicine, 5*(3), 224-232.

Bartu, A., Sharp, J., Ludlow, J., & Doherty, D. (2006). Postnatal home visiting for illicit drug-using mothers and their infants: a randomised controlled trial. *Australian & New Zealand Journal of Obstetrics & Gynaecology, 46*(5), 419-426.

Behrman, R. (1992). U.S. Health Care for Children. *The Future of Children, 2*(2).

Behrman, R. (1993). Home Visiting. *The Future of Children, 3*(3).

Behrman, R. (1999). *Home Visiting: Recent Program Evaluations*. Los Altos, California: David and Lucile Packard Foundation.

Bell, M., Ebisu, K., & Belanger, K. (2007). Ambient Air Pollution and Low Birth Weight in Connecticut and Massachusetts *Environmental Health Perspectives, 15*(7).

Bender, K. (2003). *Evaluation of the Effectiveness of a Medicaid Funded Public Health Low Birth Weight Prevention Program*. Paper presented at the Conference Name|. Retrieved Access Date|. from URL|.

Bennett, C., Macdonald, G., Dennis, J., Coren, E., Patterson, J., Astin, M., et al. (2007). Home-based support for disadvantaged adult mothers. *Cochrane Database of Systematic Reviews*(3), CD003759.

Bennett, T. (2002). Reproductive health care in the rural United States. *JAMA: Journal of the American Medical Association, 287*(1), 112.

Benowitz, N., Porchet, H., & Jacob, P. (1990). Pharmacokinetics, metabolism, and pharmacodynamics of nicotine. In S. Wonnacott, M. Russell & I. Stolerman (Eds.), *Nicotine Psychopharmacology: Molecular, Cellular, and Behavioural Aspects* (pp. 112-157). Oxford: Oxford University Press.

Berkowitz, G., Blackmore-Prince, C., Lapinski, R., & Savitz, D. (1998). Risk factors for preterm birth subtypes. *Epidemiology, 9*(3), 279-285.

Berkowitz, G., & Papiernik, E. (1993). Epidemiology of preterm birth. *Epidemiologic Reviews, 15*(2), 414-443.

Better Health for Our Children: A National Strategy (1981).). Washington, DC: Superintendent of Documents, U.S. Government Printing Office.

BHP, B. o. H. P. (1993). Health Professional Shortage Area Primary Medical Care Designation Criteria. Retrieved December 11, 2006, from http://bhpr.hrsa.gov/shortage/hpsacritpcm.htm

Bibby, E., & Stewart, A. (2004). The epidemiology of preterm birth. *Neuroendocrinology Letters, 25 Suppl 1*, 43-47.

Bickel, G., Nord, M., Price, C., Hamilton, W., & Cook, J. (2000). *U.S. Household Food Security Survey Module*: United States Department of Agriculture USDA.

Bitler, M., & Currie, J. (2005). Does WIC work? The effects of WIC on pregnancy and birth outcomes. *Journal of Policy Analysis & Management, 24*(1), 73-91.

Black, M., Dubowitz, H., Hutcheson, J., Berenson-Howard, J., & Starr, R. (1995). A Randomized clinical Trial of Home Intervention for Children with Failure to Thrive. *Pediatrics, 95*(6), 807-814.

Black, M., Mair, P., Kight, C., Wachtel, R., Roby, P., & Schuler, M. (1994). Parenting and Early Development Among Children of Drug-Abusing Women: Effects of Home Intervention Part 1 of 2. *Pediatrics, 94*(4), 440-448.

Bobak, M. (2000). Outdoor air pollution, low birth weight, and prematurity. *Environmental Health Perspectives, 108*(2), 173-176.

Bohn, D. (2002). Lifetime and current abuse, pregnancy risks, and outcomes among Native American women. *Journal of Health Care for the Poor and Underserved., 13*(2), 184-198.

Booth, C., Mitchell, S., Barnard, K., & Spieker, S. (1989). Development of maternal social skills in multi-problem families: Effects on the mother-child relationship. *Developmental Psychology, 25*, 403-412.

Borja, J., & Adair, L. (2003). Assessing the net effect of young maternal age on birthweight. *American Journal of Human Biology, 15*(6), 733-740.

Bradley, P., & Martin, J. (1994). The impact of home visits on enrollment patterns in pregnancy-related services among low-income women. *Public Health Nursing 11*(6), 392-398.

Braveman, P., Pearl, M., Egerter, S., Marchi, K., & Williams, R. (1998). Validity of insurance information on California birth certificates. *American Journal of Public Health, 88*(5), 813-816.

BRFSS. (2007). BRFSS Frequently Asked Questions (FAQs). Retrieved September 15, 2007, from http://www.cdc.gov/brfss/faqs.htm#5

Bronfenbrenner, U. (1979). *The Ecology of Human Development: Experiments by Nature and Design*. Cambridge, MA: Harvard University Press.

Brooten, D., Youngblut, J. M., Brown, L., Finkler, S. A., Neff, D. F., & Madigan, E. (2001). A randomized trial of nurse specialist home care for women with high-risk pregnancies: outcomes and costs. *American Journal of Managed Care, 7*(8), 793-803.

Brown, M., McLaine, P., Dixon, S., & Simon, P. (2006). A randomized, community-based trial of home visiting to reduce blood lead levels in children.[see comment]. *Pediatrics, 117*(1), 147-153.

Bryce, R., Stanley, F., & Garner, J. (1991). Randomized controlled trial of antenatal social support to prevent preterm birth. *British Journal of Obstetrics & Gynaecology, 98*(10), 1001-1008.

Bubolz, M., & Sontag, M. (1993). Human Ecology Theory. In P. Boss, W. Doherty, R. LaRossa, W. Schumm & S. Steinmetz (Eds.), *Sourcebook of family theories and methods: A contextual approach* (pp. 419 - 448). New York: Plenum Press.

Buescher, P., & Horton, S. (2000). *Prenatal WIC Participation in Relation to Low Birth Weight and Medicaid Infant Costs in North Carolina – A 1997 Update*. Raleigh, NC: Center for Health Informatics and Statistics.

Buescher, P., Taylor, K., Davis, M., & Bowling, J. (1993). The quality of the new birth certificate data: a validation study in North Carolina. *American Journal of Public Health 93*(8), 1163-1165.

Buescher, P., & Ward, N. (1992). A comparison of low birth weight among Medicaid patients of public health departments and other providers of prenatal care in North Carolina and Kentucky. *Public Health Reports, 107*(1), 54-59.

Bushy, A. (1998). Health issues of women in rural environments: an overview. *Journal of the American Medical Womens Association, 53*(2), 53-56.

Byrd, M. (1995). The home visiting process in the contexts of the voluntary vs. required visit: examples from fieldwork. *Public Health Nursing, 12*(3), 196-202.

Byrd, M. (1997). Child-Focused Single Home Visiting. *Public Health Nursing, 14*(5), 313-322.

Cappleman, M., Thompson, R., DeRemer-Sullivan, P., King, A., & Sturm, J. (1982). Effectiveness of a home based early intervention program with infants of adolescent mothers. *Child Psychiatry & Human Development, 13*(1), 55-65.

Carlson, N., & Lowe, N. (2006). Centering pregnancy: a new approach in prenatal care. *MCN: The American Journal of Maternal/Child Nursing 31*(4), 218-223.

Casey, M., Thiede Call, K., & Klingner, J. (2001). Are rural residents less likely to obtain recommended preventive healthcare services? *American Journal of Preventive Medicine, 21*(3), 182-188.

CDC. (1990). Effects of maternal cigarette smoking on birth weight and preterm birth--Ohio, 1989. *MMWR - Morbidity & Mortality Weekly Report, 39*(38), 662-665.

CDC. (1993). *Instruction Manual, Part 3a—Classification and Coding Instructions for Live Birth Records*. Retrieved. from.

CDC. (2000). *2000 Surgeon General's Report—Reducing Tobacco Use*. Atlanta GA.

CDC. (2001). *Women and Smoking*. Atlanta: Centers for Disease Control and Prevention.

CDC. (2004). Smoking During Pregnancy --- United States, 1990--2002 *MMWR, 53*(39), 911-915

CDC. (2006a). Sexually Transmitted Disease Treatment Guidelines. *MMWR 55*(RR 11).

CDC. (2006b). Youth Risk Behavior Surveillance - United States, 2005. *MMWR Surveillance Summaries, 55*(SS05), 1-108.

CDC. (2007). Smokeless Tobacco Fact Sheet. Retrieved September 5, 2007, from http://www.cdc.gov/tobacco/data_statistics/Factsheets/smokeless_tobacco.htm

Census. (2006). Selected Economic Characteristics. *American Fact Finder* Retrieved September 26, 2007, from

http://factfinder.census.gov/servlet/ADPTable?_bm=y&-geo_id=01000US&-qr_name=ACS_2006_EST_G00_DP3&-ds_name=ACS_2006_EST_G00_&-_lang=en&-_sse=on

CFR. (1973). Schedules of Controlled Substances (Vol. 11): Drug Enforcement Administration, Department of Justice.

Chandiramani, M., & Shennan, A. (2006). Preterm labour: update on prediction and prevention strategies. *Current Opinion in Obstetrics & Gynecology, 18*(6), 618-624.

Chapman, J., Siegel, E., & Cross, A. (1990). Home Visitors and Child Health: Analysis of Selected Programs. *Pediatrics, 85*(6), 1059-1068.

Chelmow, D., Andrew, D., & Baker, E. (1996). Maternal cigarette smoking and placenta previa. *Obstetrics & Gynecology, 87*(5 Pt 1), 703-706.

Chen, P., Pan, I., & Wang, J. (2006). Parental exposure to lead and small for gestational age births. *American Journal of Industrial Medicine, 49*(6), 417-422.

Cherry, D., Burk, C., & Woodwell, D. (2003). *National Ambulatory Medical Care Survey: 2001 Summary* Retrieved. from.

Cherry, D., Woodwell, D., & Rechtsteiner, E. (2007). National Ambulatory Medical Care Survey: 2005 Summary. *Advance Data from Vital and Health Statistics, 387*.

Chihara, H., Otsubo, Y., Yoneyama, Y., Sawa, R., Suzuki, S., Power, G. G., et al. (2003). Basal metabolic rate in hyperemesis gravidarum: comparison to normal pregnancy and response to treatment. *American Journal of Obstetrics & Gynecology, 188*(2), 434-438.

Child Abuse and Neglect: Critical First Steps in Response to a National Emergency. (1990).). Washington, DC: United States Advisory Board on Child Abuse and Neglect.

Chiles, L. (1989). Preventing infant mortality. *Academic Medicine, 64*(6), 310-311.

Ciliska, D., Hayward, S., Thomas, H., Mitchell, A., Dobbins, M., Underwood, J., et al. (1996). A systematic overview of the effectiveness of home visiting as a delivery strategy for public health nursing interventions. *Canadian Journal of Public Health Revue Canadienne de Sante Publique, 87*(3), 193-198.

Cleary-Goldman, J., Malone, F. D., Vidaver, J., Ball, R. H., Nyberg, D. A., Comstock, C. H., et al. (2005). Impact of maternal age on obstetric outcome. *Obstetrics & Gynecology, 105*(5 Pt 1), 983-990.

Cliver, S., Goldenberg, R., Cutter, G., Hoffman, H., Davis, R., & Nelson, K. (1995). The effect of cigarette smoking on neonatal anthropometric measurements. *Obstetrics & Gynecology, 85*(4), 625-630.

CMS. (2007). Medicaid Management Information System. Retrieved December 14, 2007, from http://www.cms.hhs.gov/MMIS/

Cnattingius, S., Forman, M., Berendes, H., Graubard, B., & Isotalo, L. (1993). Effect of age, parity, and smoking on pregnancy outcome: a population-based study. *American Journal of Obstetrics & Gynecology, 168*(1 Pt 1), 16-21.

Cnattinguis, S., Bergstrom, R., Lipworth, L., & Kramer, M. S. (1998). Prepregnancy weight and the risk of adverse pregnancy outcomes. *New England Journal of Medicine, 338*, 147-152.

Coburn, A., MacKinney, A., McBride, T., Mueller, K., Slifkin, R., & Wakefield, M. (2007). *Choosing Rural Definitions: Implications for Health Policy* (No. 2): Rural Policy Research Institute Health Panel.

Cole, N., & Fox, M. (2004). *Nutrition and Health characteristics of Low-Income Populations: volume II, WIC Participants and NonParticipants*: USDA, United States Department of Agriculture

Collins, J. W., Jr., Schulte, N. F., & Drolet, A. (1998). Differential effect of ecologic risk factors on the low birthweight components of African-American, Mexican-American, and non-Latino white infants in Chicago. *Journal of the National Medical Association, 90*(4), 223-229.

Combs-Orme, T., Reis, J., & Ward, L. D. (1985). Effectiveness of home visits by public health nurses in maternal and child health: an empirical review. *Public Health Reports, 100*(5), 490-499.

Committee, E. (2003). Report of the expert committee on the diagnosis and classification of diabetes mellitus. *Diabetes Care, 26 Suppl 1*, S5-20.

Committee, P. (2004). Guidelines on the number of embryos transferred. *Fertility & Sterility, 82*(3), 773-774.

Cramer, M., Chen, L., Roberts, S., & Clute, D. (2007). Evaluating the social and economic impact of community-based prenatal care. *Public Health Nursing 24*(4), 329-336.

Crawford, P. (2002). Epilepsy and pregnancy. *Seizure, 11 Suppl A*, 212-219.

Croteau, A., Marcoux, S., & Brisson, C. (2006). Work activity in pregnancy, preventive measures, and the risk of delivering a small-for-gestational-age infant. *American Journal of Public Health, 96*(5), 846-855.

Cuevas, K., Silver, D., Brooten, D., Youngblut, J., & Bobo, C. (2005). The cost of prematurity: hospital charges at birth and frequency of rehospitalizations and acute care visits over the first year of life: a comparison by gestational age and birth weight. *American Journal of Nursing, 105*(7), 56-64; quiz 65.

Culhane, J., Rauh, V., McCollum, K., Hogan, V., Agnew, K., & Wadhwa, P. (2001). Maternal stress is associated with bacterial vaginosis in human pregnancy. *Maternal & Child Health Journal, 5*(2), 127-134.

Cunningham, F., Hauth, J., Leveno, K., Gilstrap III, L., Bloom, S., & Wenstrom, K. (Eds.). (2005). *Williams Obstetrics* (22 nd ed.). New York: McGraw Hill.

Curry, M. (1998). The Interrelationships Between Abuse, Substance Use, and Psychosocial Stress During Pregnancy. *JOGNN - Journal of Obstetric, Gynecologic, & Neonatal Nursing, 27*(6), 692-699.

Curry, M., Burton, D., & Fields, J. (1998). The Prenatal Psychosocial Profile: A Research and Clinical Tool. *Research in Nursing & Health, 21*, 211-219.

Curry, M., Durham, L., Bullock, L., Bloom, T., & Davis, J. (2006). Nurse case management for pregnant women experiencing or at risk for abuse. *JOGNN - Journal of Obstetric, Gynecologic, & Neonatal Nursing, 35*(2), 181-192.

CYWHS. (2005). *Family Home Visiting Service Outline*: Government of South Australia.

Dabrowski, S., Hanke, W., Polaska, K., Makowiec-Dabrowska, T., & Sobala, W. (2003). Pesticide exposure and birthweight: an epidemiological study in Central Poland.

International Journal of Occupational Medicine & Environmental Health, *16*(1), 31-39.

Davenport, E., Williams, C., Sterne, J., Murad, S., Sivapathasundram, V., & Curtis, M. (2002). Maternal periodontal disease and preterm low birthweight: case-control study. *Journal of Dental Research*, *81*(5), 313-318.

Davis, R., Helgerson, S., & Waller, P. (1992). Smoking during pregnancy among Northwest Native Americans. *Public Health Reports*, *107*(1), 66-69.

Dayan, J., Creveuil, C., Marks, M. N., Conroy, S., Herlicoviez, M., Dreyfus, M., et al. (2006). Prenatal depression, prenatal anxiety, and spontaneous preterm birth: a prospective cohort study among women with early and regular care. *Psychosomatic Medicine, 68*(6), 938-946.

Dew, P., Guillory, V., Okah, F., Cai, J., & Hoff, G. (2007). The effect of health compromising behaviors on preterm births. *Maternal and Child Health Journal, 11*(3), 227-233.

DHHS. (1989). *Caring for our future: the content of prenatal care* Washington: U.S. Department of Health and Human Services Public Health Service.

DHHS. (2003). *TECHNICAL APPENDIX FROM VITAL STATISTICS OF THE UNITED STATES: 2002 NATALITY*. Hyattsville, Maryland: CENTERS FOR DISEASE CONTROL AND PREVENTION NATIONAL CENTER FOR HEALTH STATISTICS.

DHHS. (2007). Healthy People 2010. Retrieved Janaury 4, 2007, from http://www.healthypeople.gov/About/

Diego, M., Jones, N., Field, T., Hernandez-Reif, M., Schanberg, S., Kuhn, C., et al. (2006). Maternal psychological distress, prenatal cortisol, and fetal weight. *Psychosomatic Medicine, 68*(5), 747-753.

Dietz, P., Callaghan, M., Cogswll, M., Morrow, B., Ferre, C., & Schieve, L. A. (2006). Combined Effects of Prepregnancy Body Mass Index and Weight Gain During Pregnancy on the Risk of Preterm Delivery. *Epidemiology, 17*(2), 170-177.

DiGiuseppe, D., Aron, D., Ranbom, L., Harper, D., & Rosenthal, G. (2002). Reliability of birth certificate data: a multi-hospital comparison to medical records information. *Maternal & Child Health Journal, 6*(3), 169-179.

Dobie, S., Baldwin, L., Rosenblatt, R., Fordyce, M., Andrilla, C., & Hart, L. (1998). How well do birth certificates describe the pregnancies they report? The Washington State experience with low-risk pregnancies. *Maternal & Child Health Journal, 2*(3), 145-154.

Dodd, C. (1996). *A Workable Balance: Report to Congress on Family and Medical Leave Policies*. Washington, D.C. : Commission On Family and Medical Leave.

Dodds, L., Fell, D., Joseph, K., Allen, V., & Butler, B. (2006). Outcomes of pregnancies complicated by hyperemesis gravidarum. *Obstetrics & Gynecology, 107*(2 Pt 1), 285-292.

Doggett, C., Burrett, S., & Osborn, D. A. (2005). Home visits during pregnancy and after birth for women with an alcohol or drug problem. *Cochrane Database of Systematic Reviews, 3*(4), CD004456.

DOL. (2006a). *Multiple jobholders and multiple jobholding rates by sex and race*. Retrieved. from http://www.bls.gov/cps/wlf-table35-2005.pdf.

DOL. (2006b). *Table 36. Multiple jobholders by selected demographic and economic characteristics*. Retrieved. from http://www.bls.gov/cps/cpsaat36.pdf.

Dolan-Mullen, P., Ramirez, G., & Groff, J. Y. (1994). A meta-analysis of randomized trials of prenatal smoking cessation interventions. *American Journal of Obstetrics & Gynecology*, *171*(5), 1328-1334.

Donovan, E., Ammerman, R., Besl, J., Atherton, H., Khoury, J., Altaye, M., et al. (2007). Intensive home visiting is associated with decreased risk of infant death. *Pediatrics*, *119*(6), 1145-1151.

DPHHS. (1990). Eligibility Requirements for the Noninstitutionalized Categorically Needy (Vol. 37.82.701): State of Montana.

DPHHS. (1995a). Birth registration (2007 ed., Vol. 50-15-221): State of Montana, Department of Public Health and Human Services.

DPHHS. (1995b). *Montana Vital Statistics 1994*. Helena: Department of Public Health and Human Services Bureau of Vita Statistics.

DPHHS. (2001a). Case Management Services for High Risk Pregnant Women (Vol. 37.86.3401): State of Montana.

DPHHS. (2001b). *Certificate of Live Birth*. Retrieved. from.

DPHHS. (2003). *Montana Vital Statistics 2002*. Helena, MT: Montana Department of Public Health and Human Services, Office of Vital Statistics

DPHHS. (2005). *Montana Vital Statistics 2004*. Helena: Montana Department of Public Health and Human Services, Office of Vital Statistics.

DPHHS. (2006). *Montana Vital Statistics 2005*. Helena, MT: Montana Department of Public Health and Human Services, Office of Vital Statistics.

Drillien, C. (1957). The social and economic factors affecting the incidence of premature birth. I. Premature births without complications of pregnancy. *Journal of Obstetrics & Gynaecology of the British Empire, 64*(2), 161-184.

Duggan, A., Fuddy, L., Burrell, L., Higman, S. M., McFarlane, E., Windham, A., et al. (2004). Randomized trial of a statewide home visiting program to prevent child abuse: impact in reducing parental risk factors.[see comment]. *Child Abuse & Neglect, 28*(6), 623-643.

Edgar, J. (2007). Birth Certificate In J. A. Dotson (Ed.). Helena, MT.

El-Kamary, S., Higman, S., Fuddy, L., McFarlane, E., Sia, C., & Duggan, A. (2004). Hawaii's healthy start home visiting program: determinants and impact of rapid repeat birth. *Pediatrics, 114*(3), e317-326.

El Kady, D., Gilbert, W. M., Xing, G., & Smith, L. H. (2005). Maternal and neonatal outcomes of assaults during pregnancy. *Obstetrics and Gynecology 105*(2), 357-363.

El Mallah, K., Narchi, H., Kulaylat, N., & Shaban, M. (1997). Gestational and pre-gestational diabetes: comparison of maternal and fetal characteristics and outcome. *International Journal of Gynaecology & Obstetrics, 58*(2), 203-209.

Elkan, R., Kendrick, D., Hewitt, M., Robinson, J. J., Tolley, K., Blair, M., et al. (2000). The effectiveness of domiciliary health visiting: a systematic review of international studies and a selective review of the British literature. *Health Technology Assessment (Winchester, England), 4*(13), i-v.

EPA. (2006). Air Quality Index Report: EPA Region 8 (CO, MT, ND, SD, UT, WY). *Air Data* Retrieved June 5, 2007, from

http://iaspub.epa.gov/airsdata/ADAQS.aqi?geotype=re&geocode=08&geoinfo=re%7E08%7EEPA+Region+8+%28CO+MT+ND+SD+UT+WY%29&pol=&year=2006&sumtype=co&fld=gname&fld=gcode&fld=stabbr&fld=regn&rpp=25&page=1&sort=d10&fmt=

EPA. (2007). Region 8 - Superfund Retrieved June 13, 2007, 2007

Erickson, K., Thorsen, P., Chrousos, G., Grigoriadis, D. E., Khongsaly, O., McGregor, J., et al. (2001). Preterm birth: associated neuroendocrine, medical, and behavioral risk factors. *Journal of Clinical Endocrinology & Metabolism, 86*(6), 2544-2552.

Eskenazi, B., Prehn, A. W., & Christianson, R. E. (1995). Passive and active maternal smoking as measured by serum cotinine: the effect on birthweight. *American Journal of Public Health, 85*(3), 395-398.

Espelin, D. (1990). MIAMI Program. In J. A. Dotson (Ed.). Helena.

Fang, J., Madhavan, S., & Alderman, M. H. (1999). The influence of maternal hypertension on low birth weight: differences among ethnic populations. *Ethnicity & Disease, 9*(3), 369-376.

Fantuzzi, G., Aggazzotti, G., Righi, E., Facchinetti, F., Bertucci, E., Kanitz, S., et al. (2007). Preterm delivery and exposure to active and passive smoking during pregnancy: a case-control study from Italy. *Paediatric and Perinatal Epidemiology, 21*(3), 194-200.

Farel, A., Freeman, V., Keenan, N., & Huber, C. (1991). Interaction between high-risk infants and their mothers: the NCAST as an assessment tool. *Research in Nursing & Health 14*(2), 109-118.

Faugier, J., & Sargeant, M. (1997). Sampling hard to reach populations. *Journal of Advanced Nursing, 26*(4), 790-797.

Faust, R. (1993). *Toxicity Summary for Trichloroethene* Biomedical Environmental Information Analysis Section, Health and Safety Research Division, Oak Ridge National Laboratory.

FCHB. (1995). MIAMI Project Training. Helena MT.

FCHB. (2002a). *Local MIAMI Project Report*.

FCHB. (2002b). MIAMI Project Training. Helena MT.

Feldman, J., Minkoff, H., McCalla, S., & Salwen, M. (1992). A cohort study of the impact of perinatal drug use on prematurity in an inner-city population. *American Journal of Public Health 82*(5), 726-728.

Feldman, P., Dunkel-Schetter, C., Sandman, C., & Wadhwa, P. (2000). Maternal social support predicts birth weight and fetal growth in human pregnancy. *Psychosomatic Medicine, 62*(5), 715-725.

Fetrick, A., Christensen, M., & Mitchell, C. (2003). Does Public Health Nursing Home Visitation Make a Difference in the Health Outcomes of Pregnant Clients and Their Offspring? *Public Health Nursing, 20*(3), 165-248.

Field, A. (2000). *Discovering Statistics using SPSS for Windows*. Thousand Oaks, California: Sage Publications.

Finer, L., & Henshaw, S. (2006). Disparities in rates of unintended pregnancy in the United States, 1994 and 2001. *Perspectives on Sexual & Reproductive Health, 38*(2), 90-96.

Fiscella, K. (1995). Does Prenatal Care Improve Birth Outcomes? A Critical Review. *Obstretics & Gynecology, 85*(3), 468 - 479.

Fraser, A., Brockert, J., & Ward, R. (1995). Association of Young Maternal Age with Adverse Reproductive Outcomes. *New England Journal of Medicine, 332*(17), 1113-1117.

Frazier, L., Golbeck, A., & Lipscomb, L. (2001). Medically recommended cessation of employment among pregnant women in Georgia. *Obstetrics & Gynecology, 97*(6), 971-975.

French, G., Groner, J., Wewers, M., & Ahijevych, K. (2007). Staying smoke free: an intervention to prevent postpartum relapse. *Nicotine & Tobacco Research, 9*(6), 663-670.

Frick, D. (2009). PHHV Report. Helena, MT: DPHHS.

Gabbe, S., & Turner, L. (1997). Reproductive hazards of the American lifestyle: work during pregnancy.[see comment]. *American Journal of Obstetrics & Gynecology, 176*(4), 826-832.

Gallagher, J., Botsko, J., & Schwalberg, R. (2004). *Influencing Interventions to Promote Positive Pregnancy Outcomes and Reduce the Incidence of Low Birth Weight and Preterm Infants*. Washington, DC: Health Systems Research, Inc. - Prepared for the March of Dimes.

GAO. (1992). *Early Intervention: Federal Investments Like WIC Can Produce Savings* (No. HRD 92-18). Washington, D.C.: U.S. General Accounting Office

Gazmararian, J., Lazorick, S., Spitz, A., Ballard, T., Saltzman, L., & Marks, J. (1996). Prevalence of violence against pregnant women.[erratum appears in JAMA 1997 Apr 9;277(14):1125]. *JAMA, 275*(24), 1915-1920.

Gazolla, C., Ribeiro, A., Moyses, M., Oliveira, L., Pereira, L., & Sallum, A. (2007). Evaluation of the incidence of preterm low birth weight in patients undergoing periodontal therapy. *Journal of Periodontology, 78*(5), 842-848.

GCHD. (2007). *Universal Newborn Home Visiting Program*: Guilford County Health Department.

Gennaro, S., & Hennessy, M. (2003). Psychological and physiological stress: impact on preterm birth. *JOGNN - Journal of Obstetric, Gynecologic, & Neonatal Nursing, 32*(5), 668-675.

Gerstman, B. (1998). *Epidemiology kept simple: An introduction to classic and modern epidemiology.* New York: John Wiley & Sons.

Giacoia, G. (1992). Reproductive hazards in the workplace. *Obstetrical & Gynecological Survey, 47*(10), 679-687.

Gielen, A., O'Campo, P., Faden, R., Kass, N., & Xue, X. (1994). Interpersonal conflict and physical violence during the childbearing year. *Social Science & Medicine, 39*(6), 781-787.

Gilliam, M., Rosenberg, D., & Davis, F. (2002). The likelihood of placenta previa with greater number of cesarean deliveries and higher parity.[see comment]. *Obstetrics & Gynecology, 99*(6), 976-980.

Gillum, R., & Sullins, D. (2008). Cigarette Smoking During Pregnancy: Independent Associations with Religious Participation. *Southern Medical Journal, 101*(7), 686-692.

Glynn, L., Wadhwa, P., Dunkel-Schetter, C., Chicz-Demet, A., & Sandman, C. (2001). When stress happens matters: effects of earthquake timing on stress responsivity in pregnancy.[see comment]. *American Journal of Obstetrics & Gynecology, 184*(4), 637-642.

Goldenberg, R., Cliver, S., Mulvihill, F., Hickey, C., Hoffman, H., Klerman, L., et al. (1996). Medical, psychosocial, and behavioral risk factors do not explain the increased risk for low birth weight among black women. *American Journal of Obstetrics & Gynecology, 175*(5), 1317-1324.

Goldenberg, R., & Culhane, J. (2007). Low birth weight in the United States. *American Journal of Clinical Nutrition, 85*(2), 584S-590S.

Goldenberg, R., & Rouse, D. (1998). Medical Progress: Prevention of Premature Birth. *New England Journal of Medicine, 339*(5), 313-320.

Gomby, D. (1999). Understanding Evaluations of Home Visitation Programs. *The Future of Children: Home Visiting: Recent Program Evaluations, 9*(1), 27 - 43.

Gomby, D., Culross, P., & Behrman, R. (1999). Home Visiting: Recent Program Evaluations-Analysis and Recommendations. *The Future of Children, 9*(1).

Gomby, D., Larson, C., Lewit, E., & Behrman, R. (1993). Home Visiting: Analysis and Recommendations. *The Future of Children, 3*(3), 6-22.

Gomez, R., Romero, R., Edwin, S. S., & David, C. (1997). Pathogenesis of preterm labor and preterm premature rupture of membranes associated with intraamniotic infection. *Infectious Disease Clinics of North America, 11*(1), 135-176.

Goncalves, L., Chaiworapongsa, T., & Romero, R. (2002). Intrauterine infection and prematurity. *Mental Retardation & Developmental Disabilities Research Reviews, 8*(1), 3-13.

Goodwin, L. (2009). Communication from L. Goodwin. In J. Dotson (Ed.) (pp. Response to Request). Helena.

Goodwin, L., Iannacchione, M., Hammond, W., Crockett, P., Maher, S., & Schlitz, K. (2001). Data mining methods find demographic predictors of preterm birth. *Nursing Research, 50*(6), 340-345.

Goodwin, L., VanDyne, M., Lin, S., & Talbert, S. (2003). Data mining issues and opportunities for building nursing knowledge. *Journal of Biomedical Informatics, 36*(4-5), 379-388.

Goodwin, P., Garrett, D., & Galal, O. (2005). Women and family health: the role of mothers in promoting family and child health. *International Journal of Global Health and Health Disparities 4*(1), 30-42.

Gould, J. (1999). Measurement: Vital records for quality improvement. *Pediatrics, 108*, 278-291.

Grace, J. (1989). *The assessment of the mother-newborn interaction.* THE UNIVERSITY OF ROCHESTER, Rochester.

Graham, J., Zhang, L., & Schwalberg, R. (2007). Association of maternal chronic disease and negative birth outcomes in a non-Hispanic black-white Mississippi birth cohort. *Public Health Nursing 24*(4), 311-317.

Graham, M., White, B., Clarke, C., & Adams, S. (2001). Infusing infant mental health practices into front-line caregiving. *Infants and Young Children 14*(1), 14-23

Grana, M. (2005). *Pioneer Doctor: The Story of a Woman's Work* Helena MT: Falcon Press.

Gray, S., Sheeder, J., O'Brien, R., & Stevens-Simon, C. (2006). Having the best intentions is necessary but not sufficient: what would increase the efficacy of home visiting for preventing second teen pregnancies? *Prevention Science, 7*(4), 389-395.

Gregory, K., & Davidson, E. (1999). Prenatal Care: Who Needs It and Why? *Clinical Obstetrics & Gynecology December, 42*(4), 725.

Gregory, K., Johnson, C., Johnson, T., & Entman, S. (2006). The content of prenatal care. Update 2005. *Womens Health Issues, 16*(4), 198-215.

Grossman, D., Baldwin, L., Casey, S., Nixon, B., Hollow, W., & Hart, L. (2002). Disparities in infant health among American Indians and Alaska natives in US metropolitan areas. *Pediatrics, 109*(4), 627-633.

Grossman, D., Krieger, J., Sugarman, J., & Forquera, R. (1994). Health status of urban American Indians and Alaska Natives. A population-based study. *JAMA, 271*(11), 845-850.

Guillory, V., Samuels, M., Probst, J., & Sharp, G. (2003). Prenatal care and infant birth outcomes among Medicaid recipients. *Journal of Health Care for the Poor and Underserved, 14*(2), 272-289.

Gupta, P., & Sreevidya, S. (2004). Smokeless tobacco use, birth weight, and gestational age: population based, prospective cohort study of 1217 women in Mumbai, India. *BMJ, 328*(7455), 1538.

Guralnik, D. (Ed.). (1982). *Webster's New World Dictionary*. New York: Simon and Schuster.

Gutelius, M., & Kirsch, A. (1975). Factors promoting success in infant education. *American Journal of Public Health, 65*(4), 384-387.

Guven, S. (2004). *Dimension Reduction*. Paper presented at the Conference Name|. Retrieved Access Date|. from URL|.

Haas, J., Fuentes-Afflick, E., Stewart, A., Jackson, R., Dean, M. L., Brawarsky, P., et al. (2005). Prepregnancy Health Status and the Risk of Preterm Delivery. *Archives of Pediatrics & Adolescent Medicine January, 159*(1), 58-63.

Halpern, R. (1993). The Societal Context of Home Visiting and Related Services for Families in Poverty. *The Future of Children: Home Visiting, 3*(3), 158-171.

Hamilton, B., Minino, A., Martin, J., Kochanek, K., Strobino, D., & Guyer, B. (2007). Annual summary of vital statistics: 2005. *Pediatrics, 119*(2), 345-360.

Hanke, W., Kalinka, J., Makowiec-Dabrowska, T., & Sobala, W. (1999). Heavy physical work during pregnancy--a risk factor for small-for-gestational-age babies in Poland. *American Journal of Industrial Medicine, 36*(1), 200-205.

Hanke, W., Romitti, P., Fuortes, L., Sobala, W., & Mikulski, M. (2003). The use of pesticides in a Polish rural population and its effect on birth weight. *International Archives of Occupational & Environmental Health, 76*(8), 614-620.

Hanks, C., Kitzman, H., & Milligan, R. (1995). Implementing the COACH Relationship Model: Health promotion for mothers and children. *Advances in Nursing Science, 18*(2), 57-66.

Hanley, J. (1989). Receiver operating characteristic (ROC) methodology: the state of the art. *Critical Reviews in Diagnostic Imaging, 29*(3), 307-335.

Hart, G. (2006). *Use of RUCAs in Health Services Research*. Paper presented at the Conference Name|. Retrieved Access Date|. from URL|.

Haynes, G., Dunnagan, T., & Christopher, S. (2003). Determinants of alcohol use in pregnant women at risk for alcohol consumption. *Neurotoxicology & Teratology, 25*(6), 659-666.

Heaman, M. (2005). Relationships between physical abuse during pregnancy and risk factors for preterm birth among women in Manitoba. *JOGNN - Journal of Obstetric, Gynecologic, & Neonatal Nursing, 34*(6), 721-731.

Heaman, M., Chalmers, K., Woodgate, R., & Brown, J. (2007). Relationship work in an early childhood home visiting program. *Journal of Pediatric Nursing, 22*(4), 319-330.

Hearing on House Bill 773, House, 1989 Sess. (1989).

Hedegaard, M., Henriksen, T. B., Sabroe, S., & Secher, N. J. (1993). Psychological distress in pregnancy and preterm delivery. *British Medical Journal, 307*(6898), 234-239.

Hedges, S., Simmes, D., Martinez, A., Linder, C., & Brown, S. (2005). A home visitation program welcomes home first-time moms and their infants. *Home Healthcare Nurse, 23*(5), 286-289.

Hedley, A., Ogden, C., Johnson, C., Carroll, M., Curtin, L., & Flegal, K. (2004). Prevalence of overweight and obesity among US children, adolescents, and adults, 1999-2002.[see comment]. *JAMA, 291*(23), 2847-2850.

Heinicke, C., Beckwith, L., & Thompson, A. (1988). Early Intervention in the Family System: A Framework and Review. *Infant Mental Health Journal, 9*(2), 111-141.

Hellerstedt, W., Himes, J., Story, M., Alton, I., & Edwards, L. (1997). The effects of cigarette smoking and gestational weight change on birth outcomes in obese and normal-weight women. *American Journal of Public Health 87*(4), 591-596.

Henderson, D. (2003). PHHV programs. In J. A. Dotson (Ed.) (pp. Personal communication). Helena.

Henderson, D. (2007). PHHV Contracts. In J. Dotson (Ed.) (pp. Existing status of PHHV contracts). Helena MT.

Herbst, M., Mercer, B., Beazley, D., Meyer, N., & Carr, T. (2003). Relationship of prenatal care and perinatal morbidity in low-birth-weight infants. *American Journal of Obstetrics & Gynecology, 189*(4), 930-933.

Herrera, J., Alvarado, J., & Matrinez, J. (1998). The psychosocial environment and cellular immunity in the pregnant patient *Stress Medicine, 4*(49), 49–56.

Herzig, K., Danley, D., Jackson, R., Petersen, R., Chamberlain, L., & Gerbert, B. (2006). Seizing the 9-month moment: Addressing behavioral risks in prenatal patients. *Patient Education and Counseling, 61*(2), 228-235.

HICGC. (2007). Lower Price Hill Maternal Smoking Intervention. 2008, from http://www.the-collaborative.org/HealthImprovementInitiatives/PreventionofLowBirthWeight/tabid/224/Default.aspx

Hickey, C., Cliver, S., Mulvihill, F., McNeal, S., Hoffman, H., & Goldenberg, R. (1995). Employment-related stress and preterm delivery: a contextual examination. *Public Health Reports, 110*(4), 410-418.

Hillemeier, M., Weisman, C., Chase, G., & Dyer, A. (2007). Individual and community predictors of preterm birth and low birthweight along the rural-urban continuum in central Pennsylvania. *Journal of Rural Health, 23*(1), 42-48.

Hillier, S., Nugent, R., Eschenbach, D., Krohn, M., Gibbs, R., Martin, D., et al. (1995). Association between bacterial vaginosis and preterm delivery of a low-birth-weight infant. The Vaginal Infections and Prematurity Study Group.[see comment]. *New England Journal of Medicine, 333*(26), 1737-1742.

Hobel, C. (2004). Stress and Preterm Birth. *Clinical Obstetrics & Gynecology December, 47*(4), 856-880.

Hobel, C., Dunkel-Schetter, C., Roesch, S., Castro, L., & Arora, C. (1999). Maternal plasma corticotropin-releasing hormone associated with stress at 20 weeks' gestation in pregnancies ending in preterm delivery. *American Journal of Obstetrics & Gynecology, 180*(1 Pt 3), S257-263.

Hodnett, E., & Fredericks, S. (2007). Support during pregnancy for women at increased risk of low birthweight babies. *Cochrane Database of Systematic Reviews*(3), CD000198.

Hogue, C., & Bremner, J. (2005). Stress model for research into preterm delivery among black women. *American Journal of Obstetrics & Gynecology, 192*(5 Suppl), S47-55.

Homer, C., Beresford, S., James, S., Siegel, E., & Wilcox, S. (1990). Work-related physical exertion and risk of preterm, low birthweight delivery. *Paediatric and Perinatal Epidemiology, 4*(2), 161-174.

Hoyert, D. (2007). *Maternal mortality and related concepts*. Retrieved. from http://www.cdc.gov/nchs/data/series/sr_03/sr03_033.pdf.

Hulley, S., Cummings, S., Browner, W., Grady, D., Hearst, N., & Newman, T. (2001). *Designing Clinical Research: An Epidemiological Approach* (Second ed.). Philidelphia: Lippincott, Williams & Wilkins.

Hulme, P., & Blegen, M. (1999). Residential status and birth outcomes: is the rural/urban distinction adequate? *Public Health Nursing 16*(3), 176-181.

Huynh, M., Woodruff, T. J., Parker, J. D., & Schoendorf, K. C. (2006). Relationships between air pollution and preterm birth in California. *Paediatric and Perinatal Epidemiology, 20*(6), 454-461.

Iams, J. (2003). The epidemiology of preterm birth. *Clinics in Perinatology, 30*(4), 651-664.

Ickovics, J., Kershaw, T., Westdahl, C., Rising, S., Klima, C., Reynolds, H., et al. (2003). Group prenatal care and preterm birth weight: results from a matched cohort study at public clinics. *Obstetrics & Gynecology, 102*(5 Pt 1), 1051-1057.

IES. (2007). Digest of Education Statistics: National Center for Education Statistics.

IOM. (1985). *Preventing Low Birthweight*: Division of Health Promotion and Disease Prevention

IOM. (1990a). Part I. Weight Gain. In *Nutrition During Pregnancy*. Washington, DC: National Academy Press.

IOM. (1990b). Recommended Ranges of Total Weight Gain for Pregnant Women by Prepregnancy Body Mass Index (BMI) for Singleton Gestation: Institute of Medicine.

Jack, S., DiCenso, A., & Lohfeld, L. (2005). A theory of maternal engagement with public health nurses and family visitors. *Journal of Advanced Nursing, 49*(2), 182-190.

Jasinski, J. (2004). Pregnancy and domestic violence: a review of the literature. *Trauma, Violence, & Abuse: A Review Journal 5*(1), 47-64.

Jelliffe-Pawlowski, L., Miles, S., Courtney, J., Materna, B., & Charlton, V. (2006). Effect of magnitude and timing of maternal pregnancy blood lead (Pb) levels on birth outcomes. *Journal of Perinatology, 26*(3), 154-162.

Johnson, K. (2001). *No Place Like Home: State Home Visiting Policies and Programs* (No. 452): The Commonwealth Fund.

Jones, J. (2005, December 5). Nurses Remain Atop Honesty and Ethics List *Business and Economy* Retrieved November 4, 2007, from http://www.gallup.com/poll/20254/Nurses-Remain-Atop-Honesty-Ethics-List.aspx

Josberger, R. (2007). Inquiry regarding findings from article entitled *Validation of birth certificate data in New York State* from Journal of Community Health 28-5,

(2003). In J. A. Dotson (Ed.) (pp. Our study did look at the Clinical Estimate of Gestation in weeks and it was found to be accurate in 374 of the 400 records, or 393.375% of the time.). New York.

Joseph, K., Kramer, J., Marcoux, S., Ohlsson, A., Wen, S., Allen, A., et al. (1998). Determinants of Preterm Birth Rates in Canada from 1981 through 1983 and from 1992 through 1994. *New England Journal of Medicine, 339*(20), 1434-1439.

Joyce, T., Gibson, D., & Colman, S. (2005). The changing association between prenatal participation in WIC and birth outcomes in New York City. *Journal of Policy Analysis & Management, 24*(4), 661-685.

Jurewicz, J., Hanke, W., Makowiec-Dabrowska, T., & Sobala, W. (2005). Exposure to pesticides and heavy work in greenhouses during pregnancy: does it effect birth weight? *International Archives of Occupational & Environmental Health, 78*(5), 418-426.

Kaestener, R., Joyce, T., & Wehbeh, H. (1996). The effect of maternal drug use on birth weight: measurement error in binary variables. *Economic Inquiry, 34*, 326-352.

Kaiser. (2006). Income Eligibility Levels for Pregnant Women Applying for Medicaid by Annual Income and as a Percent of Federal Poverty Level (FPL) *State Health Facts* Retrieved June 14, 2007, from http://www.statehealthfacts.org/comparetable.jsp?ind=206&st=3

Kaji, M., & Nishi, Y. (2006). Lead and Growth. *Clinical Pediatric Endocrinology 15*(4), 123-128.

Kallen, B., Finnstrom, O., Nygren, K., Otterblad Olausson, P., & Wennerholm, U. (2005). In vitro fertilisation in Sweden: obstetric characteristics, maternal

morbidity and mortality. *BJOG: An International Journal of Obstetrics & Gynaecology, 112*(11), 1529-1535.

Kaye, D., Mirembe, F., Bantebya, G., Johansson, A., & Ekstrom, A. (2006). Domestic violence during pregnancy and risk of low birthweight and maternal complications: a prospective cohort study at Mulago Hospital, Uganda. *Tropical Medicine & International Health, 11*(10), 1576-1584.

Kearney, M., York, R., & Deatrick, J. (2000). Effects of Home Visits to Vulnerable Young Families. *Journal of Nursing Scholarship, 32*(4), 369-376.

Keeling, A. (2006). "Carrying ointments and even pills!" Medicines in the work of Henry Street Settlement visiting nurses, 1893-1944. *Nursing History Review, 14*, 7-30.

Kelly, R. H., Russo, J., Holt, V. L., Danielsen, B. H., Zatzick, D. F., Walker, E., et al. (2002). Psychiatric and substance use disorders as risk factors for low birth weight and preterm delivery. *Obstetrics & Gynecology, 100*(2), 297-304.

Kempe, C. H. (1976). Approaches to preventing child abuse. The health visitors concept. *American Journal of Diseases of Children, 130*(9), 941-947.

Kent, G. G. (2006). WIC's promotion of infant formula in the United States. *International Breastfeeding Journal, 1*(8).

Kermack, W. O., McKendrick, A. G., & McKinlay, P. L. (2001). Death-rates in Great Britain and Sweden. Some general regularities and their significance. *International Journal of Epidemiology, 30*(4), 678-683.

Kesmodel, U., Olsen, S. F., & Secher, N. J. (2000). Does alcohol increase the risk of preterm delivery? *Epidemiology, 11*(5), 512-518.

Khader, Y. S., & Ta'ani, Q. (2005). Periodontal diseases and the risk of preterm birth and low birth weight: a meta-analysis.[see comment]. *Journal of Periodontology, 76*(2), 161-165.

Khanjani, N., & Sim, M. R. (2007). Maternal contamination with PCBs and reproductive outcomes in an Australian population. *Journal of Exposure Science & Environmental Epidemiology, 17*(2), 191-195.

Kharrazi, M., DeLorenze, G. N., Kaufman, F. L., Eskenazi, B., Bernert, J. T., Jr., Graham, S., et al. (2004). Environmental tobacco smoke and pregnancy outcome. *Epidemiology, 15*(6), 660-670.

Kirchengast, S., & Hartmann, B. (2003). Impact of maternal age and maternal somatic characteristics on newborn size. *American Journal of Human Biology, 15*(2), 220-228.

Kistka, Z., Palomar, L., Lee, K., Boslaugh, S., Wangler, M., Cole, F., et al. (2007). Racial disparity in the frequency of recurrence of preterm birth. *American Journal of Obstetrics & Gynecology, 196*(2), 131.e131-136.

Kitzman, H., Olds, D., Sidora, K., Henderson, C., Hanks, C., Cole, R., et al. (2000). Enduring Effects of Nurse Home Visitation on Maternal Life Course: A 3 Year Follow-up of a Randomized Trial. *JAMA, 283*(15), 1983-1989.

Kitzman, H., Olds, D. L., Henderson, C. R., Jr., Hanks, C., Cole, R., Tatelbaum, R., et al. (1997). Effect of prenatal and infancy home visitation by nurses on pregnancy outcomes, childhood injuries, and repeated childbearing. A randomized controlled trial.[see comment]. *JAMA, 278*(8), 644-652.

Kochanek, K., & Martin, J. (2005). Supplemental analyses of recent trends in infant mortality. *International Journal of Health Services, 35*(1), 101-115.

Kogan, M., Alexander, G., Kotelchuck, M., & Nagey, D. (1994). Relation of the content of prenatal care to the risk of low birth weight. Maternal reports of health behavior advice and initial prenatal care procedures. *JAMA, 271*(17), 1340-1345.

Kogan, M., Martin, J., Alexander, G., Kotelchuck, M., Ventura, S., & Frigoletto, F. (1998). The Changing Pattern of Prenatal Care Utilization in the United State, 1981-1995, Using Different Prenatal Care Indices. *JAMA, 279*(20), 1623 - 1628.

Koniak-Griffin, D., Anderson, N. L., Verzemnieks, I., & Brecht, M. L. (2000). A public health nursing early intervention program for adolescent mothers: outcomes from pregnancy through 6 weeks postpartum. *Nursing Research, 49*(3), 130-138.

Korebrits, C., Ramirez, M., Watson, L., Brinkman, E., Bocking, A., & Challis, J. (1998). Maternal CRH is increased with impending preterm birth. *Journal of Clinical Endocrinology and Metabolism, 179*, 1079-1085.

Korfmacher, J., O'Brien, R., Hiatt, S., & Olds, D. (1999). Differences in Program Implementation Between Nurses and Paraprofessionals Providing Home Visits During Pregnancy and Infancy: A Randomized Trial. *American Journal of Public Health, 89*(12), 1847-1851.

Kotelchuck, M. (1994a). The adequacy of prenatal care utilization index: Its U.S. distribution and association with low birthweight. . *American Journal of Public Health, 84*, 1486-1489.

Kotelchuck, M. (1994b). An evaluation of the Kessner Adequacy of Prenatal Care Index and a proposed Adequacy of Prenatal Care Utilization Index. *American Journal of Public Health, 84*(9), 1414-1420.

Kotelchuck, M. (1994). Overview of Adequacy of Prenatal Care Utilization Index. The University of North Carolina at Chapel Hill: Department of Maternal and Child Health.

Kozak, L. J., DeFrances, C. J., & Hall, M. J. (2006). National Hospital Discharge Survey: 2004 Annual SummaryWith Detailed Diagnosis and Procedure Data. *Vital and Health Statistics, 13*(162).

Kramer, M. S. (1987). Determinants of low birth weight: methodological assessment and meta-analysis. *Bulletin of the World Health Organization, 65*(5), 663-737.

Krugman, R. (1993). Universal Home visiting: A Recommendation form the U.S. Advisory Board on Child Abuse and Neglect. *The Future of Children, 3*(3), 184-191.

Kung, H., Hoyert, D., Xu, J., & Murphy, S. (2007). Deaths: Preliminary Data for 2005. In C. f. D. C. a. Prevention (Ed.): Division of Vital Statistics.

Kurki, T., Sivonen, A., Renkonen, O. V., Savia, E., & Ylikorkala, O. (1992). Bacterial vaginosis in early pregnancy and pregnancy outcome. *Obstetrics & Gynecology, 80*(2), 173-177.

Lane, S., Cibula, D., Milano, L., Shaw, M., Bourgeois, B., Schweitzer, F., et al. (2001). Racial and ethnic disparities in infant mortality: risk in social context. *Journal of Public Health Management & Practice, 7*(3), 30-46.

Laraia, B. A., Siega-Riz, A. M., Gundersen, C., & Dole, N. (2006). Psychosocial factors and socioeconomic indicators are associated with household food insecurity among pregnant women. *Journal of Nutrition, 136*(1), 177-182.

Larson, S. L., Eyerman, J., Foster, M. S., & Gfroerer, J. C. (2007). *Worker Substance Use and Workplace Policies and Programs* (No. DHHS Publication No. SMA 07-4273, Analytic Series A-29). Rockville, MD: DHHS, Substance Abuse and Mental Health Services Administration, Office of Applied Studies.

Lasker, J. N., Coyle, B., Li, K., & Ortynsky, M. (2005). Assessment of risk factors for low birth weight deliveries. *Health Care for Women International 26*(3), 262-280.

Launer, L. J., Villar, J., Kestler, E., & de Onis, M. (1990). The effect of maternal work on fetal growth and duration of pregnancy: a prospective study. *British Journal of Obstetrics & Gynaecology, 97*(1), 62-70.

Lee, E., Mitchell-Herzfeld, S., Lowenfels, A., Greene, R., Dorabawila, V., & DuMont, K. (2009). Reducing Low Birth Weight Trough Home Visitation: A Randomized Controlled Trial. *American Journal of Preventive Medicine, 36*(2), 154-160.

Leibowitz, A., Klerman, J. A., & Waite, L. (1992). *Women's Employment During Pregnancy and Following Birth*: The Rand Corporation.

Leonardson, G. R., & Loudenburg, R. (2003). Risk factors for alcohol use during pregnancy in a multistate area. *Neurotoxicology & Teratology, 25*(6), 651-658.

Lepercq, J., Coste, J., Theau, A., Dubois-Laforgue, D., & Timsit, J. (2004). Factors associated with preterm delivery in women with type 1 diabetes: a cohort study. *Diabetes Care, 27*(12), 2824-2828.

Lewis, J. (2007). Florence Nightengale. *Women's History* Retrieved November 2, 2007, from http://womenshistory.about.com/od/nightingale/p/nightingale.htm

LFD. (1989). Hearing on House Bill 773. In L. F. Division (Ed.), *Senate Committee on Finance and Claims* (1989 ed.). Helena MT: Legislative Services.

Lieberman, E., Gremy, I., Lang, J. M., & Cohen, A. P. (1994). Low birthweight at term and the timing of fetal exposure to maternal smoking. *American Journal of Public Health, 84*(7), 1127-1131.

Lin, S., Hwang, S., Marshall, E., & Marion, D. (1998). Does Paternal Occupational Lead Exposure Increase the Risks of Low Birth Weight or Prematurity? . *American Journal of Epidemiology, 148*(2), 173-181.

Little, M., Shah, R., Vermeulen, M. J., Gorman, A., Dzendoletas, D., & Ray, J. G. (2005). Adverse perinatal outcomes associated with homelessness and substance use in pregnancy. *CMAJ Canadian Medical Association Journal, 173*(6), 615-618.

Liu, S., Krewski, D., Shi, Y., Chen, Y., & Burnett, R. T. (2003). Association between gaseous ambient air pollutants and adverse pregnancy outcomes in Vancouver, Canada.[see comment]. *Environmental Health Perspectives, 111*(14), 1773-1778.

Livingston, S. (2002). *Student's Guide to Landmark Congressional Laws on Social Security and Welfare*. Portsmouth, NH Greenwood Press

Lobel, M., DeVincent, C., Kaminer, A., & Meyer, B. (2000). The Impact of Prenatal Maternal Stress and Optimistic Disposition on Birth Outcomes in Medically High-Risk Women. *Health Psychology 19*(6), 544-553.

Lockwood, C. J. (2002). Predicting premature delivery -- no easy task. *New England Journal of Medicine, 346*(4), 282-284.

Longnecker, M., Klebanoff, M., Brock, J., & Guo, X. (2005). Maternal levels of polychlorinated biphenyls in relation to preterm and small-for-gestational-age birth. *Epidemiology, 16*(5), 641-647.

Lu, G., Rouse, D., DuBard, M., Cliver, S., Kimberlin, D., & Hauth, J. (2001). The effect of the increasing prevalence of maternal obesity on perinatal morbidity. *American Journal of Obstetrics & Gynecology, 185*(4), 845-849.

Lu, M., & Halfon, N. (2003). Racial and ethnic disparities in birth outcomes: a life-course perspective. *Maternal & Child Health Journal, 7*(1), 13-30.

Lundsberg, L. S., Bracken, M. B., & Saftlas, A. F. (1997). Low-to-moderate gestational alcohol use and intrauterine growth retardation, low birthweight, and preterm delivery. *Annals of Epidemiology 7*(7), 498-508.

Luo, Z., Wilkins, R., & Kramer, M. (2006). Effect of neighbourhood income and maternal education on birth outcomes: a population-based study. *CMAJ Canadian Medical Association Journal, 174*(10), 1415-1420.

Luo, Z., Wilkins, R., Platt, R., & Kramer, M. (2004). Risks of adverse pregnancy outcomes among Inuit and North American Indian women in Quebec, 1985-97. *Paediatric and Perinatal Epidemiology, 18*(1), 40-50.

Lydon-Rochelle, M., Holt, V., Nelson, J., Cardenas, V., Gardella, C., Easterling, T., et al. (2005). Accuracy of reporting maternal in-hospital diagnoses and intrapartum procedures in Washington State linked birth records. *Paediatric and Perinatal Epidemiology, 19*(6), 460-471.

MacDorman, M., Munson, M., & Kirmeyer, S. (2007). Fetal and Perinatal Mortality, United States, 2004. *National Vital Statistics Reports:, 59*(3).

Mackey, M. C., & Boyle, J. S. (2000). An explanatory model of preterm labor. *Journal of Transcultural Nursing, 11*(4), 254-263.

Mackey, M. C., Williams, C. A., & Tiller, C. M. (2000). Stress, pre-term labour and birth outcomes. *Journal of Advanced Nursing, 32*(3), 666-674.

MacNaughton, M., Chalmers, I., & Dubowitz, V. (1993). Final report of the Medical Research Council/Royal College of Obstetricians and Gynaecologists multicentre randomised trial of cervical cerclage. MRC/RCOG Working Party on Cervical Cerclage. *British Journal of Obstetrics & Gynaecology, 100*(6), 516-523.

Madan, A., Palaniappan, L., Urizar, G., Wang, Y., Fortmann, S. P., & Gould, J. B. (2006). Sociocultural factors that affect pregnancy outcomes in two dissimilar immigrant groups in the United States. *Journal of Pediatrics, 148*(3), 341-346.

Makowiec-Dabrowska, T., Hanke, W., Radwan-Wlodarczyk, Z., Koszada-Wlodarczyk, W., & Sobala, W. (2003). Working condition of pregnant women. Departures from regulation on occupations especially noxious or hazardous to women. *Medycyna Pracy, 54*(1), 33-43.

Makowiec-Dabrowska, T., Radwan-Wlodarczyk, Z., Kozada-Wlodarczyk, W., Siedlecka, J., & Wilczyski, J. (1998). Relationship between chemical exposure in the workplace and the risk of premature delivery, low birth weight and intrauterine growth retardation. *International Archives of Occupational & Environmental Health, 71 Suppl*, S64-69.

Mamelle, N., Laumon, B., & Lazar, P. (1984). Prematurity and occupational activity during pregnancy. *American Journal of Epidemiology, 119*(3), 309-322.

Martin, J., Hamilton, B., Sutton, P., Ventura, J., Menacker, F., & Kirmeyer, S. (2006). *Births: Final Data for 2004*. Atlanta: CDC.

Martin, J., Hamilton, B., Sutton, P., Ventura, J., Menacker, F., & Munson, M. (2003). *Births: Final Data for 2002*. Atlanta.

Martin, J., Hamilton, B., Sutton, P., Ventura, S., Menacker, F., & Munson, M. (2005). *Births: Final Data for 2003*. Atlanta: CDC.

Martin, J., Hamilton, B., Ventura, S., Menacker, F., Melissa, M., & Sutton, P. (2002). Births: Final Data for 2001. *National Vital Statistics Reports:, 51*(2).

Martin, J., & Park, M. (1999). Trends in twin and triplet births; 1980-97. *National Vital Statistics Reports:, 47*(24).

Martin, S., Mackie, L., Kupper, L., Buescher, P., & Moracco, K. (2001). Physical abuse of women before, during, and after pregnancy. *Jama., 285*(12), 1581-1584.

Mathews, T. J., & MacDorman, M. (2007). Infant Mortality Statistics from the 2004 Period Linked Birth/Infant Death Data Set. *National Vital Statistics Reports:, 55*(14), 32.

MCA. (1995). Information on infant morbidity and mortality: State Of Montana.

McCowan, L., Buist, R., North, R., & Gamble, G. (1996). Perinatal morbidity in chronic hypertension. *British Journal of Obstetrics & Gynaecology, 103*, 123-129.

McDonald, A. D., Armstrong, B. G., & Sloan, M. (1992). Cigarette, alcohol, and coffee consumption and prematurity. *American Journal of Public Health 82*(1), 87-90.

McDuffie, R. S., Jr., Beck, A., Bischoff, K., Cross, J., & Orleans, M. (1996). Effect of frequency of prenatal care visits on perinatal outcome among low-risk women. A randomized controlled trial.[see comment]. *JAMA, 275*(11), 847-851.

McFarlane, J., Parker, B., & Soeken, K. (1996). Physical abuse, smoking, and substance use during pregnancy: prevalence, interrelationships, and effects on birth weight. *JOGNN: Journal of Obstetric, Gynecologic, and Neonatal Nursing 25*(4), 313-320.

McGrady, G. A., Sung, J. F., Rowley, D. L., & Hogue, C. J. (1992). Preterm delivery and low birth weight among first-born infants of black and white college graduates. *American Journal of Epidemiology, 136*(3), 266-276.

MCHB. (2007). Healthy Start Retrieved October 11, 2007, from http://www.hrsa.gov/about/budgetjustification08/HealthyStart.htm

McLean, M., Walters, W. A., & Smith, R. (1993). Prediction and early diagnosis of preterm labor: a critical review. *Obstetrical & Gynecological Survey, 48*(4), 209-225.

McNaughton, D. (2004). Nurse home visits to maternal-child clients: a review of intervention research. *Public Health Nursing, 21*(3), 207-219.

McNaughton, D. B. (2005). A naturalistic test of Peplau's theory in home visiting. *Public Health Nursing, 22*(5), 429-438.

Meckel, R. (1998). *Save the Babies: American Public Health Reform and the Prevention of Infant Mortality, 1850-1929* Ann Arbor: University of Michigan Press.

Meis, P. J., Goldenberg, R. L., Mercer, B. M., Iams, J. D., Moawad, A. H., Miodovnik, M., et al. (2000). Preterm Prediction Study: is socioeconomic status a risk factor

for bacterial vaginosis in Black or in White women? *American Journal of Perinatology, 17*(1), 41-45.

Meis, P. J., Michielutte, R., Peters, T. J., Wells, H. B., Sands, R. E., Coles, E. C., et al. (1995). Factors associated with preterm birth in Cardiff, Wales. II. Indicated and spontaneous preterm birth. *American Journal of Obstetrics & Gynecology, 173*(2), 597-602.

Mengel, M. B., Searight, H. R., & Cook, K. (2006). Preventing alcohol-exposed pregnancies. *Journal of the American Board of Family Medicine: JABFM, 19*(5), 494-505.

Mercer, B. M. (2003). Preterm premature rupture of the membranes. *Obstetrics & Gynecology, 101*(1), 178-193.

Merkatz, I. R., Thompson, J. E., & Walsh, L. V. (1990). History of prenatal care. . In I. R. Merkatz & J. E. Thompson (Eds.), *New Perspectives on Prenatal Care* (pp. 14). New York: Elsevier.

MIAMI Act 50-19-301 (1989).

Michalowicz, B., & Durand, R. (2007). Maternal periodontal disease and spontaneous preterm birth. *Periodontology 2000, 44*, 103-112.

Michielutte, R., Ernest, J. M., Moore, M. L., Meis, P. J., Sharp, P. C., Wells, H. B., et al. (1992). A comparison of risk assessment models for term and preterm low birthweight. *Preventive Medicine, 21*(1), 98-109.

Mills, L. W., & Moses, D. T. (2002). Oral health during pregnancy. *MCN, American Journal of Maternal Child Nursing, 27*([5]), 275-281.

MOD. (2005). Preterm Birth: US, 1994-2004. In N. C. f. H. Statistics (Ed.) (Vol. 2006): March of Dimes.

MOD. (2007). Born Too Soon and Too Small in the United States. *PeriStats* Retrieved July 14, 2007

Montan, S. (2007). Increased risk in the elderly parturient. *Current Opinion in Obstetrics & Gynecology, 19*(2), 110-112.

Moore, M. (2003). Preterm labor and birth: what have we learned in the past two decades? *JOGNN - Journal of Obstetric, Gynecologic, & Neonatal Nursing, 32*(5), 638-649.

Moore, M., & Zaccaro, D. (2000). Cigarette smoking, low birth weight, and preterm births in low-income African American women. *Journal of Perinatology, 20*(3), 176-180.

Moore, S., Ide, M., Coward, P., Randhawa, M., Borkowska, E., Baylis, R., et al. (2004). A prospective study to investigate the relationship between periodontal disease and adverse pregnancy outcome.[see comment]. *British Dental Journal, 197*(5), 251-258; discussion 247.

Moss, N., & Carver, K. (1993). Pregnant women at work: sociodemographic perspectives. *American Journal of Industrial Medicine, 23*(4), 541-557.

Moum, K. R., Holzman, G. S., Harwell, T. S., Parsons, S. L., Adams, S. D., Oser, C. S., et al. (2004). Increasing rate of diabetes in pregnancy among American Indian and white mothers in Montana and North Dakota, 1989-2000. *Maternal & Child Health Journal, 8*(2), 71-76.

Moutquin, J. (1999). A retrospective assessment of Canadian preterm birth prevention efforts: 1979-1999. *Maternal & Child Health Journal, 3*(2), 93-97.

Moutquin, J. (2003). Classification and heterogeneity of preterm birth. *BJOG: An International Journal of Obstetrics & Gynaecology, 110 Suppl 20*, 30-33.

Mozurkewich, E. L., Luke, B., Avni, M., & Wolf, F. M. (2000). Working conditions and adverse pregnancy outcome: a meta-analysis. *Obstetrics & Gynecology, 95*(4), 623-635.

Mukhopadhaya, N., & Arulkumaran, S. (2007). Reproductive outcomes after in-vitro fertilization. *Current Opinion in Obstetrics & Gynecology, 19*(2), 113-119.

Murdaugh, C. (1986). Critique of the Study Design. In L. Phillips (Ed.), *A Clinician's Guide to the Critique and Utilization of Nursing Research*. Norwalk, Connecticut: Appleton-Century-Crofts.

NCHS. (2002). *Health United States, 2002*. Atlanta, GA: Centers for Disease Control and Prevention.

NCHS. (2007a). Birth Data. *Vital Stat* Retrieved April 19, 2007, from http://www.cdc.gov/nchs/VitalStats.htm

NCHS. (2007b). Birth Data Description. Retrieved November 12, 2007, from http://www.cdc.gov/nchs/about/major/natality/natdesc.htm

NCI. (1992). *Smokeless Tobacco or Health: An International Perspective*. Bethesda, MD: U.S. Department of Health and Human Services.

NCPIM. (1989). *Home Visiting: Opening Doors for America's Pregnant Women and Children.* Washington DC: National Commission to Prevent Infant Mortality

Neumann, M., & Graf, C. (2003). Pregnancy after age 35: are these women at high risk? *AWHONN Lifelines, 7*(5), 422-430.

Newburn-Cook, C. V., & Onyskiw, J. E. (2005). Is older maternal age a risk factor for preterm birth and fetal growth restriction? A systematic review. *Health Care for Women International, 26*(9), 852-875.

Newton, R. W., & Hunt, L. P. (1984). Psychosocial stress in pregnancy and its relation to low birth weight. *British Medical Journal Clinical Research Ed, 288*(6425), 1191-1194.

NFP. (2007). Nurse Family Partnership: Helping First Time Parents Suceed. Retrieved April 14, 2007, from http://www.nursefamilypartnership.org/content/index.cfm?fuseaction=showContent&contentID=8&navID=8

Nicholson, W. K., Fox, H. E., Cooper, L. A., Strobino, D., Witter, F., & Powe, N. R. (2006). Maternal race, procedures, and infant birth weight in type 2 and gestational diabetes. *Obstetrics & Gynecology, 108*(3 Pt 1), 626-634.

NIH. (2007). Lead. *Haz Map Occupational Exposure to Hazardous Agents*, from http://hazmap.nlm.nih.gov/cgi-bin/hazmap_generic?tbl=TblAgents&id=10

Noonan, K., Reichman, N. E., Corman, H., & Dave, D. (2007). Prenatal drug use and the production of infant health. *Health Economics, 16*(4), 361-384.

Norbeck, J. S., DeJoseph, J. F., & Smith, R. T. (1996). A randomized trial of an empirically-derived social support intervention to prevent low birthweight among African American women.[see comment]. *Social Science & Medicine, 43*(6), 947-954.

Nordentoft, M., Lou, H. C., Hansen, D., Nim, J., Pryds, O., Rubin, P., et al. (1996). Intrauterine growth retardation and premature delivery: the influence of maternal smoking and psychosocial factors. *American Journal of Public Health, 86*(3), 347-354.

Norr, K., Crittenden, K., Lehrer, E., Reyes, O., Boyd, C., Nacion, K., et al. (2003). Maternal and Infant Outcomes at One Year for a Nurse-Health Advocate Home Visiting Program Serving African Americans and Mexican Americans. *Public Health Nursing, 20*(3), 190 - 203.

Northam, S., & Knapp, T. (2006). The reliability and validity of birth certificates. *JOGNN - Journal of Obstetric, Gynecologic, & Neonatal Nursing, 35*(1), 3-12.

Northam, S., Polancich, S., & Restrepo, E. (2003). Birth certificate methods in five hospitals. *Public Health Nursing 1994 Dec; 11(6): 392-8 (15 ref), 20* (4), 318-327.

Nurminen, T., Lusa, S., Ilmarinen, J., & Kurppa, K. (1989). Physical work load, fetal development and course of pregnancy. *Scandinavian Journal of Work, Environment & Health, 15*(6), 404-414.

NYC. (2007). Universal Newborn Home Visiting Program. Retrieved November 19, 2007, from http://www.cccnewyork.org/publications/NewbornColor.pdf

Offenbacher, S., Jared, H. L., O'Reilly, P. G., Wells, S. R., Salvi, G. E., & Lawrence, H. P. (1996). Periodontal infection as a possible risk factor for preterm low birth weight. *Journal of Peridontology, 67*(10), 1103-1113.

Okun, N., Gronau, K., & Hannah, M. (2005). Antibiotics for Bacterial Vaginosis or Trichomonas vaginalis in Pregnancy: A Systematic Review. *Obstetrics & Gynecology, 105*(4), 857-868.

Olds, & Kitzman, H. (1990). Can Home Visitation Improve the Health of Women and Children at Environmental Risk? *Pediatrics, 86*(1), 108-116.

Olds, D., Eckenrode, J., Henderson, C., Kitzman, H., Powers, J., Cole, R., et al. (1997). Long-term effects of home visitation on maternal life course and child abuse and neglect. Fifteen-year follow-up of a randomized trial.[see comment]. *JAMA, 278*(8), 637-643.

Olds, D., Henderson, C., Kitzman, H., & Cole, R. (1995). Effects of Prenatal and Infancy Nurse Home Vistation on Surveillance of Child Maltreatment. *Pediatrics, 95*(3), 365-372.

Olds, D., Henderson, C., Tatelbaum, R., & Chamberlin, R. (1986). Improving the delivery of prenatal care and outcomes of pregnancy: a randomized trial of nurse home visitation. *Pediatrics 77*(1), 16-28.

Olds, D., Hill, P., Robinson, J., Song, N., & Little, C. (2000). Update on home visiting for pregnant women and parents of young children. *Current Problems in Pediatrics, 30*(4), 107-141.

Olds, D., Kitzman, H., Cole, R., Robinson, J., Sidora, K., Luckey, D., et al. (2004). Effects of nurse home-visiting on maternal life course and child development: age 6 follow-up results of a randomized trial. *Pediatrics, 114*(6), 1550-1559.

Olds, D., Kitzman, H., Hanks, C., Cole, R., Anson, E., Sidora-Arcoleo, K., et al. (2007). Effects of nurse home visiting on maternal and child functioning: age-9 follow-up of a randomized trial. *Pediatrics, 120*(4), e832-845.

Olds, D., Robinson, J., O'Brien, R., Luckey, D., Pettit, L., Henderson, C., et al. (2002). Home Visiting by Paraprofessionals and by Nurses: A Randomized, Controlled Trial. *Pediatrics, 110*(3).

Olds, D., Robinson, J., Pettitt, L., Luckey, D., Holmberg, J., Ng, R., et al. (2004). Effects of home visits by paraprofessionals and by nurses: age 4 follow-up results of a randomized trial.[see comment]. *Pediatrics, 114*(6), 1560-1568.

Olds, D., Sadler, L., & Kitzman, H. (2007). Programs for parents of infants and toddlers: recent evidence from randomized trials. *Journal of Child Psychology & Psychiatry & Allied Disciplines, 48*(3-4), 355-391.

Olsen, P., Laara, E., Rantakallio, P., Jarvelin, M. R., Sarpola, A., & Hartikainen, A. L. (1995). Epidemiology of preterm delivery in two birth cohorts with an interval of 20 years. *American Journal of Epidemiology, 142*(11), 1184-1193.

OMH. (2007). Eliminate Disparities in Infant Mortality. Retrieved April 20, 2007, from http://www.cdc.gov/omh/AMH/factsheets/infant.htm#1

Page, R., Ellison, C. & Lee.J. (2008). Does Religiosity Affect Health Risk Behaviors in Pregnant and Postpartum Women? *Maternal Child Health Journal,* (August).

Page, R. L. (2004). Positive pregnancy outcomes in Mexican immigrants: what can we learn? *JOGNN - Journal of Obstetric, Gynecologic, & Neonatal Nursing, 33*(6), 783-790.

Parsons, L. (1991). Homeless families in Hackney. *Public Health, 105*(4), 287-296.

Partridge, C. A., & Holman, J. R. (2005). Effects of a reduced-visit prenatal care clinical practice guideline. *Journal of the American Board of Family Practice, 18*(6), 555-560.

Pastor, D. K. (2006). Home sweet home: a concept analysis of home visiting. *Home Healthcare Nurse, 24*(6), 389-394.

Patandin, S., Koopman-Esseboom, C., de Ridder, M. A., Weisglas-Kuperus, N., & Sauer, P. J. (1999). Effects of environmental exposure to polychlorinated biphenyls and dioxins on birth size and growth in Dutch children. *Pediatric Research, 44*(4), 538-545.

Paul, M., & Kurtz, S. (1990). *Reproductive hazards in the workplace*. Worcester (MA): Occupational and Environmental Reproductive Hazards Center, University of Massachusetts Medical Center

Peck, L., & Alexander, K. (2003). Maternal, infant, and child health in rural areas. In L. Gamm, L. Hutchinson, B. Dabney & A. Dorsey (Eds.), *Rural Healthy People 2010* (Vol. 2). College Station, TX.: The Texas A&M University System Health Science Center, School of Public Health, Southwest Rural Health Research Center.

Peoples-Sheps, M. D., Siegel, E., Suchindran, C. M., Origasa, H., Ware, A., & Barakat, A. (1991). Characteristics of maternal employment during pregnancy: effects on low birthweight.[see comment]. *American Journal of Public Health, 81*(8), 1007-1012.

Perkins, B. (2004). *The Medical Delivery Business: Health Reform, Childbirth and the Economic Order*. New Brunswick: Rutgers University Press.

Perreira, K. M., & Cortes, K. E. (2006). Race/ethnicity and nativity differences in alcohol and tobacco use during pregnancy. *American Journal of Public Health, 96*(9), 1629-1636.

Persily, C. A. (2003). Lay home visiting may improve pregnancy outcomes. *Holistic Nursing Practice, 17*(5), 231-238.

Pettit, S. (2007). History of Montana's Improved Pregnancy Outcome and MIAMI Projects. In J. A. Dotson (Ed.). Helena MT.

Piper, J., Mitchel, E., Snowden, M., Hall, C., M., A., & Taylor, P. (1993). Validation of 1989 Tennessee birth certificates using maternal and newborn hospital records. *American Journal of Epidemiology, 137*, 758-768.

Plumridge, G. (2007). Families First. Retrieved November 17, 2007, from http://www.familyfirst.org.au/state.php?gid=5

Program, M. P. (1995). *Public Health Services for At-Risk Pregnant Women and Children in Montana*. Helena MT: Health Services Division, Montana Department of Public Health and Environmental Sciences.

Public Health and Safety Division - Program Legislative Budget. (2007).): Legislative Services Staff.

Raatikainen, K., Heiskanen, N., & Heinonen, S. (2006). Does unemployment in family affect pregnancy outcome in conditions of high quality maternity care? *BMC Public Health, 6*, 46.

Rachana, C., Suraiya, K., Hisham, A., Abdulaziz, A., & Hai, A. (2002). Prevalence and complications of physical violence during pregnancy. *European Journal of Obstetrics, Gynecology, & Reproductive Biology, 103*, 26-29.

Radnai, M., Gorzo, I., Urban, E., Eller, J., Novak, T., & Pal, A. (2006). Possible association between mother's periodontal status and preterm delivery. *Journal of Clinical Periodontology, 33*(11), 791-796.

Ramey, C., & Ramey, S. (1993). Home visiting Programs and the Development of Young Children. *The Future of Children, 3*(3), 129-139.

Ray, J. G., Vermeulen, M. J., Shapiro, J. L., & Kenshole, A. B. (2001). Maternal and neonatal outcomes in pregestational and gestational diabetes mellitus, and the influence of maternal obesity and weight gain: the DEPOSIT study. Diabetes Endocrine Pregnancy Outcome Study in Toronto. *Qjm, 94*(7), 347-356.

Reichman, N., Hamilton, E., Hummer, R., & Padilla, Y. (2008). Racial and ethnic disparities in low birthweight among urban unmarried mothers. *Maternal and Child Health Journal 12*(2), 204-215.

Renker, P. R. (1999). Physical abuse, social support, self-care, and pregnancy outcomes of older adolescents. *JOGNN - Journal of Obstetric, Gynecologic, & Neonatal Nursing, 28*(4), 377-388.

Rising, S. S. (1998). Centering pregnancy - An interdisciplinary model of empowerment. *Journal of Nurse-Midwifery, 43*(1), 46-54.

Ritz, B., Yu, F., Chapa, G., & Fruin, S. (2000). Effect of air pollution on preterm birth among children born in Southern California between 1989 and 1993. *Epidemiology, 11*(5), 502-511.

Roberts, I., Kramer, M. S., & Suissa, S. (1996). Does home visiting prevent childhood injury? A systematic review of randomised controlled trials. *BMJ, 312*(7022), 29-33.

Roberts, R. O., Yawn, B. P., Wickes, S. L., Field, C. S., Garretson, M., & Jacobsen, S. J. (1998). Barriers to prenatal care: factors associated with late initiation of care in a middle-class midwestern community. *Journal of Family Practice, 47*(1), 53-61.

Rodriguez, C., Regidor, E., & Gutierrez-Fisac, J. L. (1995). Low birth weight in Spain associated with sociodemographic factors. *Journal of Epidemiology & Community Health, 49*(1), 38-42.

Rogers, M. M., Peoples-Sheps, M. D., & Suchindran, C. (1996). Impact of a social support program on teenage prenatal care use and pregnancy outcomes. *Journal of Adolescent Health, 19*(2), 132-140.

Roman, L. A., Lindsay, J. K., Moore, J. S., Duthie, P. A., Peck, C., Barton, L. R., et al. (2007). Addressing mental health and stress in Medicaid-insured pregnant women using a nurse-community health worker home visiting team. *Public Health Nursing, 24*(3), 239-248.

Romero, D., Chavkin, W., Wise, P. H., Hess, C. A., & VanLandeghem, K. (2001). State welfare reform policies and maternal and child health services: a national study. *Maternal & Child Health Journal, 5*(3), 199-206.

Roohan, P., Josberger, R., Acar, J., Dabir, P., Feder, H., & Gagliano, P. (2003). Validation of birth certificate data in New York State. *Journal of Community Health, 28*(5), 335-346.

Rosenberg, K. (2005, October 25, 2005). *Oregon PRAMS.* Paper presented at the Northwest Portland Area Indian Health Board Quarterly Meeting, Portland.

Rosenberg, T., Garbers, S., Lipkind, H., & Chiasson, M. (2005). Maternal obesity and diabetes as risk factors for adverse pregnancy outcomes: differences among 4 racial/ethnic groups. *American Journal of Public Health, 95*(9), 1545-1551.

Ruiz, R., Fullerton, J., Brown, C., & Dudley, D. (2002). Predicting risk of preterm birth: the roles of stress, clinical risk factors, and corticotropin-releasing hormone. *Biological Research for Nursing, 4*(1), 54-64.

Ruiz, R., Fullerton, J., & Dudley, D. (2003). The Interrelationships of Maternal Stress, Endocrine Factors and Inflammation on Gestational Length. *Obstetrical and Gynecological Survey, 58*(6), 415-428.

Rushing, S., & Ment, L. R. (2004). Preterm birth: a cost benefit analysis. *Seminars in Perinatology, 28*(6), 444-450.

Russell, B., Britner, P., & Woolard, J. (2007). The promise of primary prevention home visiting programs: a review of potential outcomes. *Journal of Prevention & Intervention in the Community, 34*(1-2), 129-147.

Rust, O. A., Atlas, R. O., Reed, J., van Gaalen, J., & Balducci, J. (2001). Revisiting the short cervix detected by transvaginal ultrasound in the second trimester: why cerclage therapy may not help.[see comment]. *American Journal of Obstetrics & Gynecology, 185*(5), 1098-1105.

Sable, M., & Wilkinson, D. (2000). Impact of perceived stress, major life events and pregnancy attitudes on low birth weight. *Family Planning Perspectives, 32*(6), 288-294.

Sagiv, S., Tolbert, P., Altshul, L., & Korrick, S. (2007). Organochlorine exposures during pregnancy and infant size at birth. *Epidemiology, 18*(1), 120-129.

Sandman, C., Glynn, L., Schetter, C., Wadhwa, P., Garite, T., Chicz-DeMet, A., et al. (2006). Elevated maternal cortisol early in pregnancy predicts third trimester levels of placental corticotropin releasing hormone (CRH): priming the placental clock. *Peptides, 27*(6), 1457-1463.

Sandman, C., Wadhwa, P., Glynn, L., Chicz-Demet, A., Porto, M., & Garite, T. (1999). Corticotrophin-releasing hormone and fetal responses in human pregnancy. *Annals of the New York Academy of Sciences, 897*, 66-75.

Savitz, D. A., Henderson, L., Dole, N., Herring, A., Wilkins, D. G., Rollins, D., et al. (2002). Indicators of cocaine exposure and preterm birth. *Obstetrics and Gynecology, 99*(3), 458-465.

Schieve, L. A., Meikle, S. F., Ferre, C., Peterson, H. B., Jeng, G., & Wilcox, L. S. (2002). Low and very low birth weight in infants conceived with use of assisted reproductive technology.[see comment]. *New England Journal of Medicine, 346*(10), 731-737.

Scholz, H. S., Haas, J., & Petru, E. (1999). Do primiparas aged 40 years or older carry an increased obstetric risk? *Preventive Medicine, 29*(4), 263-266.

Schorr, L., & Schorr, D. (1988). *Within our reach: Breaking the cycle of disadvantage.* New York: Anchor Doubleday.

Schuler, J., Nair, P., & Kettinger, L. (2003). Drug-Exposed Infants and Developmental Outcome: Effects of a Home Intervention and Ongoing Maternal Drug Use. *Archives of Pediatrics & Adolescent Medicine, 157*(2), 133-138.

Schwartz, I. L. (1990). Low-birth-weight effects of demographic and socioeconomic variables and prenatal care in Pima County, Arizona. *Western Journal of Medicine, 152*(6), 725-728.

Sclowitz, I., & Santos, I. (2006). Risk factors for repetition of low birth weight, intrauterine growth retardation, and prematurity in subsequent pregnancies: a systematic review. *Cadernos de Saude Publica, 22*(6), 1129-1136.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. Boston, New York: Houghton Mifflin Company.

Sheehan, D., Watt, S., Krueger, P., & Sword, W. (2006). The impact of a new universal postpartum program on breastfeeding outcomes. *Journal of Human Lactation, 22*(4), 398-408.

Shiono, P., & Behrman, R. (1995). Low Birth Weight: Analysis and Recommendations. *The Future of Children: Low Birth Weight, 5*(1).

Shiono, P., Klebanoff, M., Nugent, R., Cotch, M., Wilkins, D., Rollins, D., et al. (1995). The impact of cocaine and marijuana use on low birth weight and preterm birth: a multicenter study. *American Journal of Obstetrics & Gynecology, 172*(1 Pt 1), 19-27.

Shiono, P., Klebanoff, M., & Rhoads, G. (1986). Smoking and drinking during pregnancy. Their effects on preterm birth. *JAMA, 255*(1), 82-84.

Shitener, L., & McGranahan, D. (2003). Rural America: opportunities and challenges. *Amber Waves, 1*(1), 14-21.

Sidhu, J. S., & Floyd, R. L. (2002). Alcohol Use Among Women of Childbearing Age --- United States, 1991--1999 *MMWR, 51*(13), 273-276.

Siega-Riz, A. M., Herrmann, T. S., Savitz, D. A., & Thorp, J. M. (2001). Frequency of eating during pregnancy and its effect on preterm delivery. *American Journal of Epidemiology, 153*(7), 647-652.

Smith, C. (1947). Effects of maternal undernutrition upon the newborn infant in Holland (1944-1945). *Am J Obstet Gynecol 30*.

Smulian, J., Ananth, C., Hanley, M., Knuppel, R., Donlen, J., & Kruse, L. (2001). New Jersey's electronic birth certificate program: variations in data sources. *American Journal of Public Health 91*(5), 814-816.

Sontag, L. W. (1947). Significance of fetal environmental differences. *American Journal of Obstetrics and Gynecology, 42*, 996-1003.

Spinillo, A., Capuzzo, E., Baltaro, F., Piazza, G., Nicola, S., & Iasci, A. (1996). The effect of work activity in pregnancy on the risk of fetal growth retardation. *Acta Obstetricia et Gynecologica Scandinavica, 75*(6), 531-536.

Sprauve, M. E., Lindsay, M. K., Herbert, S., & Graves, W. (1997). Adverse perinatal outcome in parturients who use crack cocaine. *Obstetrics & Gynecology, 89*(5 Pt 1), 674-678.

SSA. (2007). TITLE IV to the Social Security Act -GRANTS TO STATES FOR AID TO DEPENDENT CHILDREN. *Social Security On line* Retrieved Nov 4, 2007, from http://www.ssa.gov/history/35activ.html

Steer, P. (2005). The epidemiology of preterm labor -- a global perspective. *Journal of Perinatal Medicine, 33*(4), 273-276.

Stein, J. A., Lu, M. C., & Gellberg, L. (2000). Severity of Homelessness and Adverse Birth Outcomes. *Health Psychology, 19*(6), 524-534.

Stein, Z., Susser, M., & Saenger, G. (1975). The Dutch Hunger Winter of 1944-1945. In *Famine and Human Development*. New York: Oxford University Press.

Stevenson, R. C., Pharoah, P. O., Stevenson, C. J., McCabe, C. J., & Cooke, R. W. (1996). Cost of care for a geographically determined population of low birthweight infants to age 8-9 years. II. Children with disability. *Archives of Disease in Childhood Fetal & Neonatal Edition, 74*(2), F118-121.

Stremlau, A. (1932). Letter to Dr. W.F. Cogswell M.D.

Sukalich, S., Mingione, M. J., & Glantz, J. C. (2006). Obstetric outcomes in overweight and obese adolescents. *American Journal of Obstetrics & Gynecology, 195*(3), 851-855.

Svikis, D. S., & Reid-Quinones, K. (2003). Screening and prevention of alcohol and drug use disorders in women. *Obstetrics & Gynecology Clinics of North America, 30*(3), 447-468.

Sweet, M. A., & Appelbaum, M. I. (2004). Is home visiting an effective strategy? A meta-analytic review of home visiting programs for families with young children. *Child Development, 75*(5), 1435-1456.

Tabachnick, B., & Fidell, L. (2001). *Using Multivariate Statistics* (4th ed.). Needham Heights, MA: Allyn & Bacon.

Tandon, D., Parillo, K., Jenkins, C., Jenkins, J., & Duggan, A. (2007). Promotion of service integration among home visiting programs and community coalitions

working with low-income, pregnant, and parenting women. *Health Promotion Practice, 8*(1), 79-87.

Telfair, J. (2005). Families and Health. In J. Kotch (Ed.), *Maternal and Child Health: Program, Problems and Policy in Public Health* (2nd ed., pp. 57-88). Sudbury, Massachusetts: Jones and Bartlett Publishers.

Thompson, M., Curry, M. A., & Burton, D. (1998). The effects of nursing case management on the utilization of prenatal care by Mexican-Americans in rural Oregon. *Public Health Nursing, 15*(2), 82-90.

To, M. S., Alfirevic, Z., Heath, V. C. F., Cicero, S., Cacho, A. M., Williamson, P. R., et al. (2004). Cervical cerclage for prevention of preterm delivery in women with short cervix: randomised controlled trial. *Lancet, 363*(9424), 1849-1853.

Tommiska, V., Tuominen, R., & Fellman, V. (2003). Economic costs of care in extremely low birthweight infants during the first 2 years of life. *Pediatric Critical Care Medicine, 4*(2), 157-163.

Tucker, J., & McGuire, W. (2004). Epidemiology of preterm birth.[see comment]. *BMJ, 329*(7467), 675-678.

Turner, T., & Eldredge, B. (2005). *Gender Wage Gaps: Factors and Fiction*.

Turner, T., & Queen, J. (2006). *Wages for Continuous Single and Multiple Jobholders in Montana*.

Twohy, K. M., & Reif, L. (1997). What do public health nurses really do during prenatal home appointments? *Public Health Nursing, 14*(6), 324-331.

USC. (1978). The Pregnancy Discrimination Act of 1978 (Vol. TITLE 42, CHAPTER 21, SUBCHAPTER VI).

USDA. (2006). WIC at a Glance. 2007, from http://www.fns.usda.gov/wic/aboutwic/wicataglance.htm

USPSTF. (2003). Counseling to Prevent Tobacco Use and Tobacco-Related Diseases: Recommendation Statement. Retrieved August 14, 2007, from http://www.ahrq.gov/clinic/3rduspstf/tobacccoun/tobcounrs.htm

Ventura, S., Martin, J., & Curtin, S. (2000). *Births: Final data for 1998*. Hyattsville, Md: National Center for Health Statistics.

Villar, J., Farnot, U., Barros, F., Victora, C., Langer, A., & Belizan, J. M. (1992). A randomized trial of psychosocial support during high-risk pregnancies. The Latin American Network for Perinatal and Reproductive Research. *New England Journal of Medicine, 327*(18), 1266-1271.

Vintzileos, A. M., Ananth, C. V., Smulian, J. C., Scorza, W. E., & Knuppel, R. A. (2002). The impact of prenatal care in the United States on preterm births in the presence and absence of antenatal high-risk conditions. *American Journal of Obstetrics & Gynecology, 187*(5), 1254-1257.

Visscher, W. A., Feder, M., Burns, A. M., Brady, T. M., & Bray, R. M. (2003). The impact of smoking and other substance use by urban women on the birthweight of their infants.[see comment]. *Substance Use & Misuse, 38*(8), 1063-1093.

Wadhwa, P. (2005). Psychoneuroendocrine processes in human pregnancy influence fetal development and health. *Psychoneuroendocrinology, 30*(8), 724-743.

Wadhwa, P., Culhane, J. F., Rauh, V., & Barve, S. S. (2001). Stress and preterm birth: neuroendocrine, immune/inflammatory, and vascular mechanisms. *Maternal & Child Health Journal, 5*(2), 119-125.

Wadhwa, P., Dunkel-Schetter, C., Chicz-DeMet, A., Porto, M., & Sandman, C. A. (1996). Prenatal psychosocial factors and the neuroendocrine axis in human pregnancy. *Psychosomatic Medicine, 58*(5), 432-446.

Wadhwa, P., Garite, T., Porto, M., Glynn, L., Chicz-DeMet, A., Dunkel-Schetter, C., et al. (2004). Placental corticotropin-releasing hormone (CRH), spontaneous preterm birth, and fetal growth restriction: a prospective investigation.[see comment]. *American Journal of Obstetrics & Gynecology, 191*(4), 1063-1069.

Wang, M., Dorer, D., Fleming, M., & Catlin, E. (2004). Clinical outcomes of near-term infants. *Pediatrics, 114*(2), 372-376.

Wang, X., Ding, H., Ryan, L., & Xu, X. (1997). Association between air pollution and low birth weight: a community-based study. *Environmental Health Perspectives, 105*(5), 514-520.

Ward, C., Lewis, S., & Coleman, T. (2007). Prevalence of maternal smoking and environmental tobacco smoke exposure during pregnancy and impact on birth weight: retrospective study using Millennium Cohort. *BMC Public Health, 7*, 81.

Wasik, B. (1993). Staffing Issues for Home Visiting Programs. In R. Behrman (Ed.), *The Future of Children: Home Visiting* (Vol. 3:3, pp. 140-157). United States: Center for the Future of Children.

Watkins, M., Edmonds, L., McClearn, A., Mullins, L., Mulinare, J., & Khoury, M. (1996). The surveillance of birth defects: the usefulness of the revised US standard birth certificate. *American Journal of Public Health, 86*, 731-734.

Weber, B., & Jensen, L. (2004). *Poverty and Place: A Critical Review of Rural Poverty Literature*. Columbia, MO: University of Missouri, RUPRI Rural Poverty Research Center.

Weisman, C. S., Hillemeier, M. M., Chase, G. A., Misra, D. P., Chuang, C. H., Parrott, R., et al. (2008). Women's perceived control of their birth outcomes in the Central Pennsylvania Women's Health Study: implications for the use of preconception care. *Womens Health Issues, 18*(1), 17-25.

Wells, C. S., Schwalberg, R., Noonan, G., & Gabor, V. (2006). Factors influencing inadequate and excessive weight gain in pregnancy: Colorado, 2000-2002. *Maternal & Child Health Journal, 10*(1), 55-62.

Wen, S. W., Smith, G., Yang, Q., & Walker, M. (2004). Epidemiology of preterm birth and neonatal outcome. *Seminars In Fetal & Neonatal Medicine, 9*(6), 429-435.

White, D., Fraser-Lee, N., Tough, S., & Newburn-Cook, C. (2006). The content of prenatal care and its relationship to preterm birth in Alberta, Canada. *Health Care for Women International, 27*(9), 777-792.

WIC/DPHHS. (2007). *FUNDING FORMULA - FEDERAL FISCAL YR 2008*. Helena MT: DPHHS.

Williams, M., & Mittendorf, R. (1993). Increasing maternal age as a determinant of placenta previa. More important than increasing parity? *Journal of Reproductive Medicine, 38*(6), 425-428.

Williams, M., Mittendorf, R., Lieberman, E., Monson, R., Schoenbaum, S., & Genest, D. (1991). Cigarette smoking during pregnancy in relation to placenta previa. *American Journal of Obstetrics & Gynecology, 165*(1), 28-32.

Woolery, L., & Grzymala-Busse, J. (1994). Machine learning for an expert system to predict preterm birth risk. . *Journal of American Medical Information Association, 1*(6), 439-446.

WWAMI. (2006). The Use of RUCAS (Version 1.11) in Health Care. *The Use of RUCAS (Version 1.11) in Health Care* Retrieved February, 2007, from http://depts.washington.edu/uwruca/ruca1/use_healthcare.html

Zaren, B., Lindmark, G., & Gebre-Medhin, M. (1996). Maternal smoking and body composition of the newborn. *Acta Paediatrica, 85*(2), 213-219.

Zerwekh, J. (1992). Laying the groundwork for family self-help: locating families, building trust, and building strength. *Public Health Nursing, 9*(1), 15-21.

Ziaei, S., Sadrkhanlu, M., Moeini, A., & Faghihzadeh, S. (2006). Effect of bacterial vaginosis on premature rupture of membranes and related complications in pregnant women with a gestational age of 37-42 weeks. *Gynecologic & Obstetric Investigation, 61*(3), 135-138.

Zotti, M., & Zahner, S. (1995). Evaluation of public health nursing home visits to pregnant women on WIC. *Public Health Nursing, 12*(5), 294-304.